Wireless World

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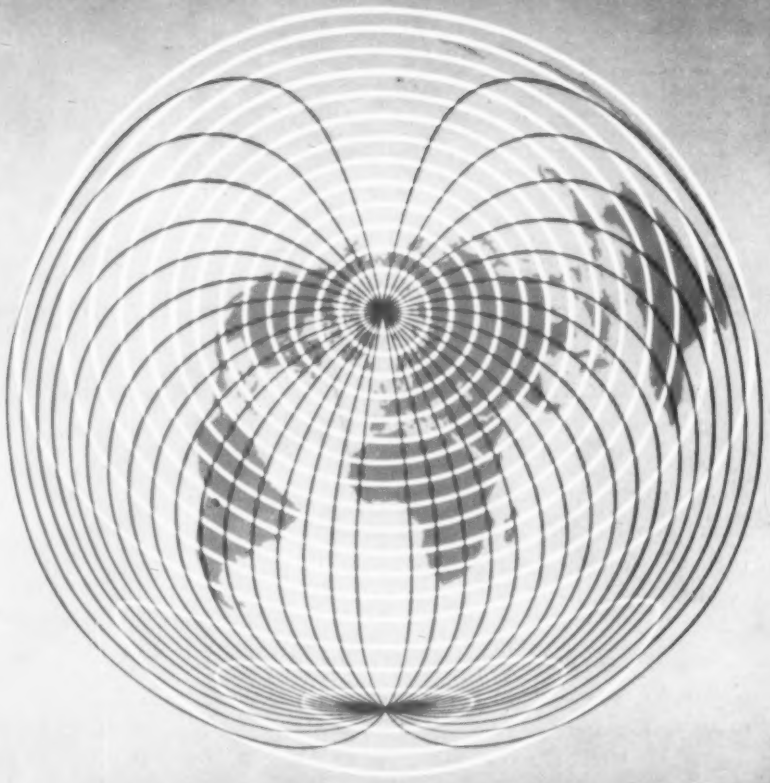

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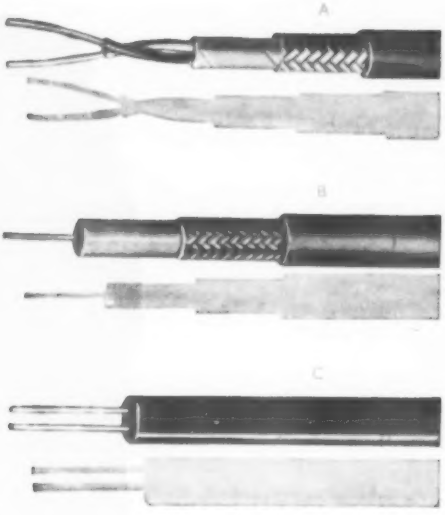

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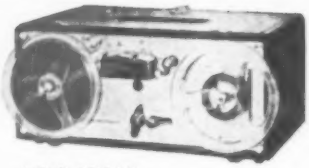


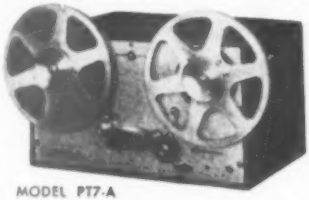
MODEL PT63-AH

Engineers! Examine these Specifications:

PT63-AH RECORDER MECHANISMS:
Frequency response: 15" tape speed: flat from 50 to 15,000 cps, ± 2 db.
7½" tape speed: flat from 50 to 7,000 cps, ± 2 db.
3¾" tape speed: flat from 50 to 4,000 cps, ± 2 db.
(Capstans furnished for 15" and 7½" speeds. 3¾" speed obtained by ordering with 2-speed motor). Signal-to-noise ratio: Exceeds 50 db with less than 2% harmonic distortion. Maximum flutter: Less than 0.3% maximum (peak-to-peak). Equipped with three recording heads for separate erase, record and playback. Fast tape forward speed control for cueing-in. Fast rewind speed control. Size of reel: 7". Auxiliary spooling mechanism is available for 10½" reels.

PT63-J AMPLIFIER for PT63-AH mechanisms: Has 600 ohm balanced zero level output plus 10 watts of audio, monitor speaker, meter, separate record and playback channels on one chassis.

OTHER ACCESSORIES: Four-channel low level microphone mixer. Throwover switch for continuous recording, using two mechanisms.



MODEL PT7-A

PT7 RECORDER MECHANISMS:
Frequency response:
15" tape speed: Flat from 50 to 15,000 cps, ± 2 db.
7½" tape speed: Flat from 50 to 7,500 cps, ± 2 db.
Signal-to-noise-ratio: Over 55 db less than 2% harmonic distortion.
Flutter and wow: 15" tape speed: Less than 0.1% maximum (peak-to-peak).
7½" tape speed: Less than 0.2% maximum (peak-to-peak).
Three recording heads for separate erase, record and playback, all shielded. High speed tape forward and rewind, (rewinds 10½" reel in 1 minute). Instantaneous start and stop (up to full speed or stop in less than 1/10 second). Two-speed control switch. Positive timing drive, interlocked pushbutton controls (can be remote controlled).

PT7 AMPLIFIERS: A line level amplifier—600 ohm balanced and bridging inputs. 600 ohm balanced zero level output. Also available, a three channel, HIGH LEVEL mixing amplifier—mixes 3 low impedance low level microphone inputs, separate and playback channels. Zero level output at 600 ohms, balanced, plus 10 watts of audio.

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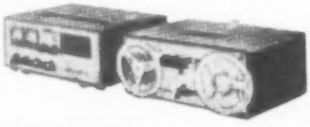
Dual recorder and amplifier for binaural recording and playback. Two sound tracks recorded simultaneously on single tape. Send coupon below for technical information on this advanced method of recording and reproduction.



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For switching, servo mechanisms and motor control applications in aircraft, ships and mobile industrial equipments, there is a series of xenon-filled thyratrons available, with anode current ratings ranging from 0.1 to 6.4 amperes. On account of the small variations-with-temperatures of xenon, these tubes are specially suitable for use in equipments operating over a large ambient temperature range.

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Brief technical details of the Mullard range of thyratrons are given below. More comprehensive information will be gladly supplied on request.

TYPE	DESCRIPTION	BASE	V_a (pk) max. (KV)	PIV max. (KV)	I_a (pk) max. (A)	I_a (av) max. (A)
MERCURY-VAPOUR						
MT17	Triode	4-pin UX	2.5	5.0	2.0	0.5
MT57	Triode	4-pin UX	1.0	1.0	15	2.5
MT105	Tetrode	B4D	2.5	2.5	40	6.4
XENON-FILLED						
2D21	Tetrode	B7G	0.65	1.3	0.5	0.1
MT5544*	Triode	B4D	1.5	1.5	40	3.2
MT5545*	Triode	B4D	1.5	1.5	80	6.4
HYDROGEN-FILLED						
ME1503	Triode	B4D	8.0	8.0	60	0.015

* *Supplies temporarily restricted to Government Contractors only.*

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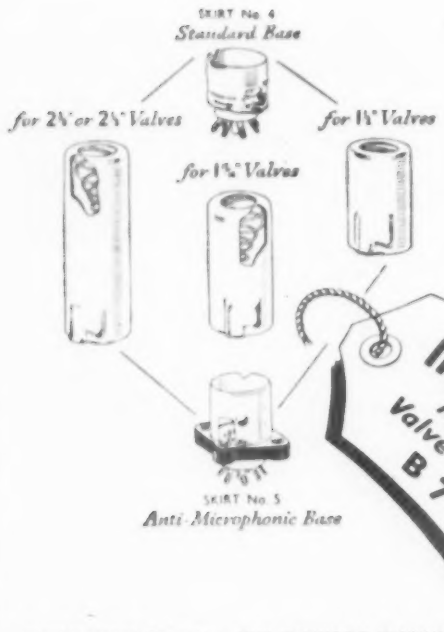

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Spare Tape Spools

7in. Diameter standard metal spools, capacity 1,200ft., 4/-. 5in diameter standard metal spools, capacity 600ft., 3/6. 7in. Diameter plastic spools, capacity 1,200ft., 4/-.

Microphones

The microphone illustrated is the standard one supplied with the Simphonic Model 2B Recorder. It is a crystal type hand microphone, and has a particular appeal because it is ideally suited for speech applications with small recording equipments. Chief characteristic is its high sensitivity at comparatively low cost. Complete with 9ft. screened lead and jack plug, £2 10 0.

Tape Joining Fluid

This special preparation is available to facilitate the splicing of broken plastic recording tapes. Dries firmly in a few seconds. Glass rod fixed into bottle cap for easy application. Per bottle 4/9.

Type DML

Recommended for use where a higher standard of quality than is obtained with the crystal type is demanded. Useful as a general purpose microphone for Public Address work as well as many other applications. Sensitivity approximately the same as the crystal type, and this microphone has a substantially even frequency response up to 6,000 cycles. Complete with heavy cast base, 9ft. screened lead and jack plug and with built-in transformer and muting switch. £7 5 0.

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T.V. SERVICING

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An Alignment Wobbulator for setting up the *correct* response curves of a T.V. receiver's tuned circuits. In addition the instrument incorporates a generator which produces a pattern of either horizontal or vertical bars on the receiver screen so that linearity of its time-bases can be checked.
A feature of the instrument is that the frequency modulation of the carrier injected into the receiver is carried out electronically, the X-sweep voltage of the oscillograph being used to control this modulation. The response curves of R.F. and I.F. tuned circuits are displayed on the oscillograph producing the sweep voltage, the 7 megacycles bandwidth of the F.M. sweep occupying the entire length of the trace. The carrier of the 'Tele-Check' can be set to any frequency between 7 and 70 megacycles.

COSSOR *Model* 1039
PORTABLE OSCILLOGRAPH

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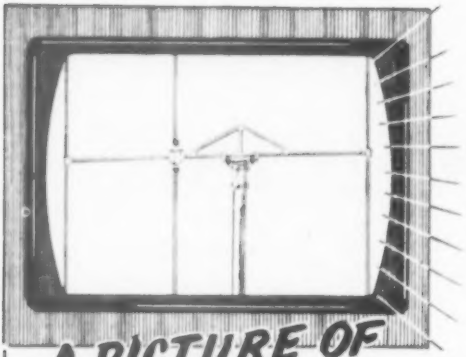

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J651T	32	350	400	200	1⅝in.	1in.	6	0
J652T	4	450	525	40	1⅛in.	⅜in.	3	0
J653T	8	450	525	75	1⅛in.	⅜in.	3	6
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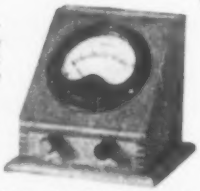

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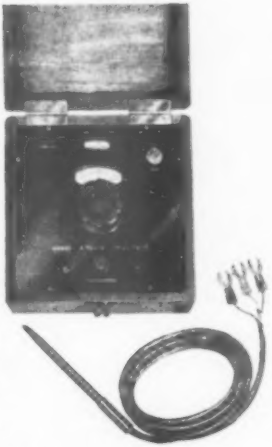

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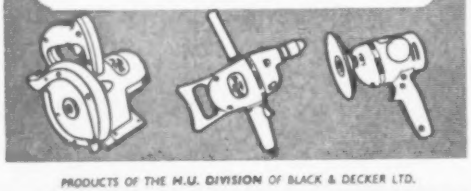

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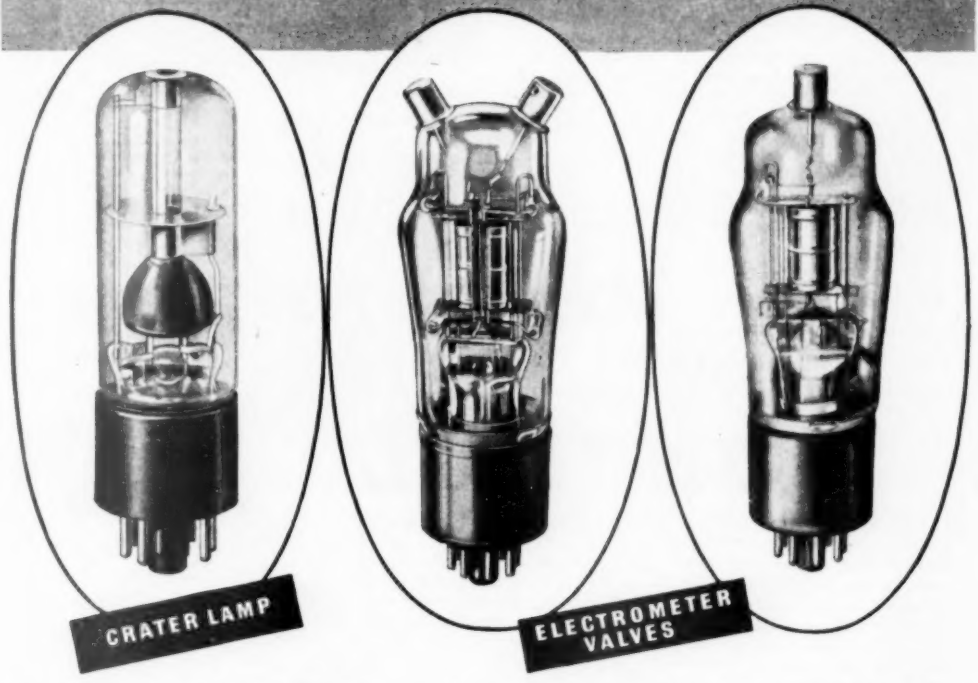

The Electronics Department of Ferranti Ltd. manufactures an extensive range of indirectly heated single and double tetrode electrometer valves with control grid currents ranging from 30×10^{-14} amps to better than 3×10^{-14} amps.

Illustrated here (centre and right) are two examples of Electrometer valves and (left) a Crater lamp, which gives a light output proportionate to the anode current. Ferranti specialize in the manufacture of industrial valves to suit a wide diversity of needs.

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Ferranti Ltd.

ELECTRONICS DEPARTMENT MOSTON MANCHESTER 10

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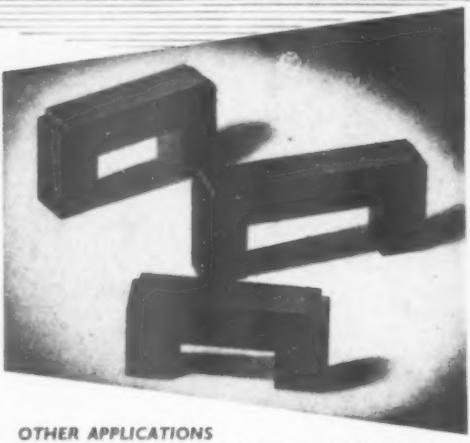
FERROMAGNETIC FERRITE

FOR TELEVISION



THE improvement in television components, with their smaller size and greater efficiency, is largely due to Ferroxcube, the new Mullard magnetic core material.

The uses of Mullard Ferroxcube in the production of TV components fall into these three main groups:

LINE OUTPUT TRANSFORMER CORES

Since the advent of wide-angle television tubes, with the accompanying demand for increased E.H.T. supplies, the need for line output transformers of the highest possible efficiency has been greater than ever. Mullard Ferroxcube, with its low iron losses, completely fulfils this need — also facilitating the assembly of small, compact transformer units by means of solid, non-laminated U-shape cores.

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Mullard Ferroxcube cores in ring form are ideal for producing the magnetic circuit around deflection coils. Used in this way, Mullard Ferroxcube makes possible the construction of efficient deflector coils with a high Q factor. In order to simplify assembly problems, these ring cores are supplied either in the form of a complete circle, as two semi-circles, or as castellated yokes.

LINEARITY AND PICTURE WIDTH CONTROLS

Mullard Ferroxcube can very conveniently be extruded into rods and tubes. In this form it is ideal for use in linearity and picture width controls, providing a smooth control in a compact assembly.

OTHER APPLICATIONS

In addition to its uses in television receivers, Mullard Ferroxcube is also being widely employed in line communications, radar, and other specialised electronic equipments. The purposes for which it is already being most successfully applied in such equipments include filter networks, wide band transformers, magnetic amplifiers, and pulse transformers.

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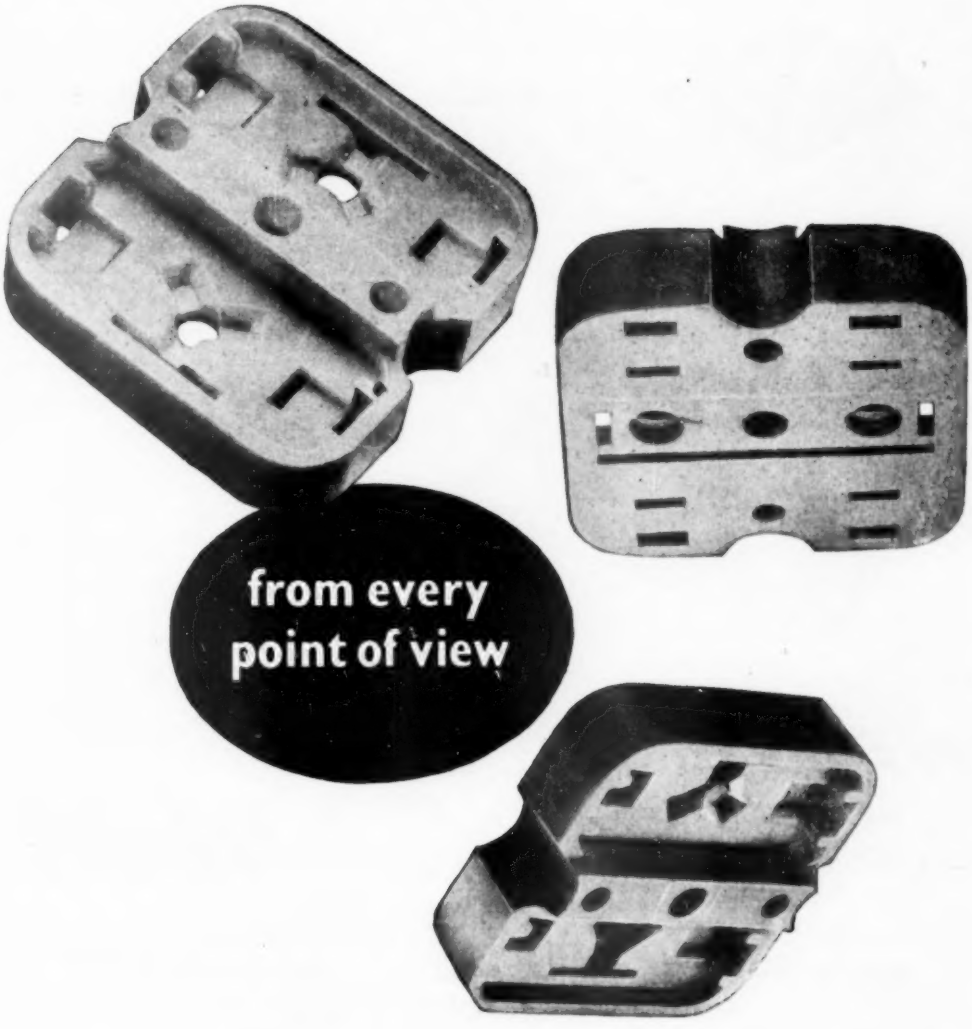

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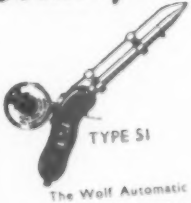
OFF-STRAIGHT EASY-GRIP HANDLE
PERFECT CONTROL · QUICKER HEAT-UP
LOCALISED HEAT · LOW CURRENT
CONSUMPTION · MAINTAINS CORRECT
HEAT · MODELS FOR EVERY PURPOSE

Automatic Soldergun

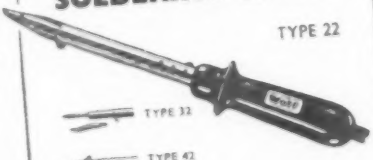


TYPE 51

The Wolf Automatic Soldergun with its automatic, trigger solder-feed action is indispensable to all modern assembly.

SOLDERING IRONS

TYPE 22



For all who, for special reasons, prefer the conventional straight-type handle. Identical as regards elements and bits to Wolf Solderguns but with round hard wooden handle with heat-deflecting skirt.

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G.E.C. instrument cathode ray tubes

The above illustration shows a typical supply network suitable for the E4205-B-7; the deflection sensitivity increases as Va3 is reduced until it is 0.28 mm/V at the minimum of 600V. G.E.C. electrostatic instrument tubes are available in four standard sizes. All have 4V heaters and short-persistence green screens. Brief details are given in the table—for further information apply to the Osram Valve and Electronics Department.

Type No.	Bulb dia. (mm)	V_{a3}	Sensitivity (mm/V)		Base
			X	Y	
E4103-B-4	39	600-1000	90 / V_{a3}	100 / V_{a3}	Brit. 9-pin
E4205-B-7	70	600-1500	170 / V_{a3}	170 / V_{a3}	B12B
E4412-B-9	90	600-4000	350 / V_{a3}	750 / V_{a3}	B12D
E4504-B-16	160	600-5000	600 / V_{a3}	1100 / V_{a3}	B12D

Special screens are available to order.

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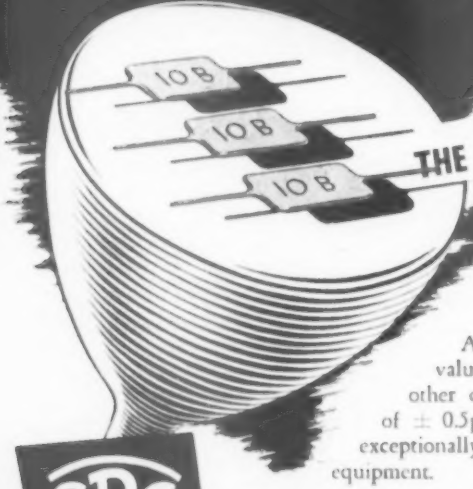

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A space saving silvered mica capacitor for the "low" value range. Widely used in television receivers and other compact electronic assemblies. A close tolerance of ± 0.5pF can be supplied economically. Stability is exceptionally high. Specify our type 10B for your miniature equipment.

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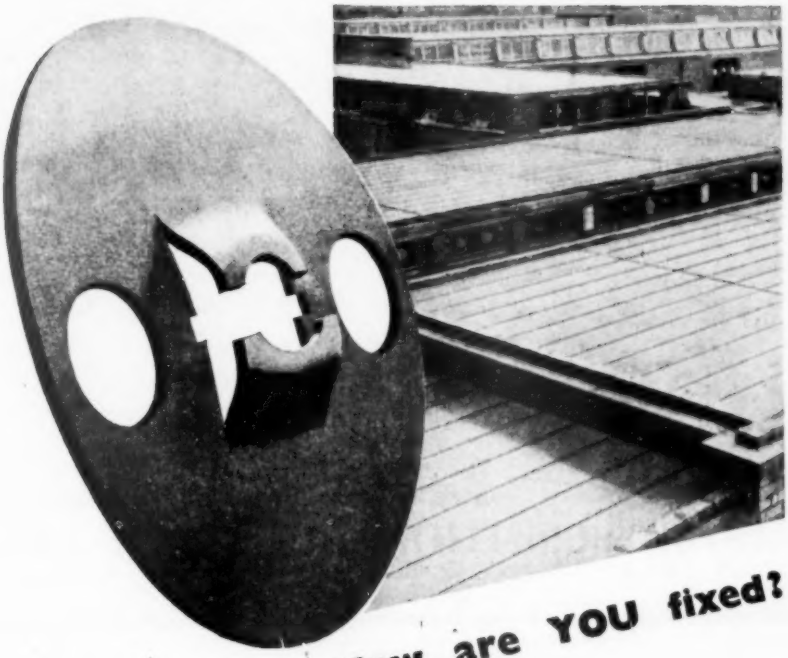

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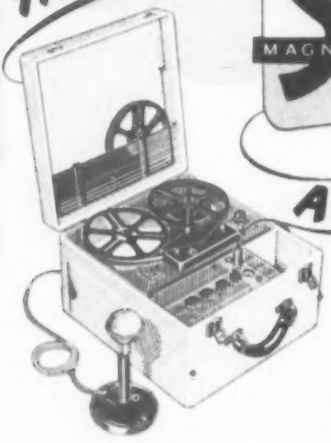
THE FIRST
THE Soundmirror
MAGNETIC TAPE RECORDER
AND FOREMOST



A self-contained recorder/reproducer giving a faultless performance. The ideal equipment for HOME ENTERTAINMENT, PUBLIC ADDRESS, CONFERENCE RECORDING, and SOUND COMMENTARY for SILENT FILM PROJECTORS.

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Now available in England—the book "Magnetic Recording" by Dr. S. J. Begun. A comprehensive treatise. Price 25/-, postage 9d. extra.

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Almost any pattern comprising pure line, halftones or a combination of both can be supplied on receipt of specific requirements, and two standard types are available.

Type J.101 — Test Chart "A"
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TYPICAL OPERATING DATA

Deflection	*electromagnetic*
Focus	*electrostatic*
Vh	6·3 *V*
Vg (cut-off)	−50 *V*
Va1	1200 *V*
Va2 (focus)	800/850 *V*
Va3 (wall)	1200 *V*
V target	1160/1200 *V*
I target	5 *μA*

Resolution better than 500 lines
Video Signal 0.5μA peak to peak (min)

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Four terminal networks, active and passive, balanced or unbalanced, can be measured.

Facilities are provided for use as a high impedance Selective Detector Amplifier.

Frequency Coverage : 1—68 Kc/s in 4 ranges.

Range of Measurements : Gain 0-60 db. Loss 0-80 db.

Accuracy : ± 0.5 db.

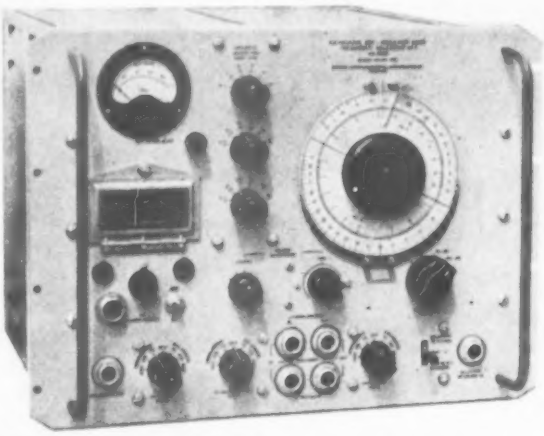
Impedance range : 75, 150 and 600 ohms., balanced or unbalanced.

Det.-Amp. Sensitivity : 10-12 μV.

Power Supplies : 100-150-200-250v. 50 c/s.

Based on Signals Research and Development Establishment design.

Manufactured for Ministry of Supply and G.P.O.



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For stabilised power supplies

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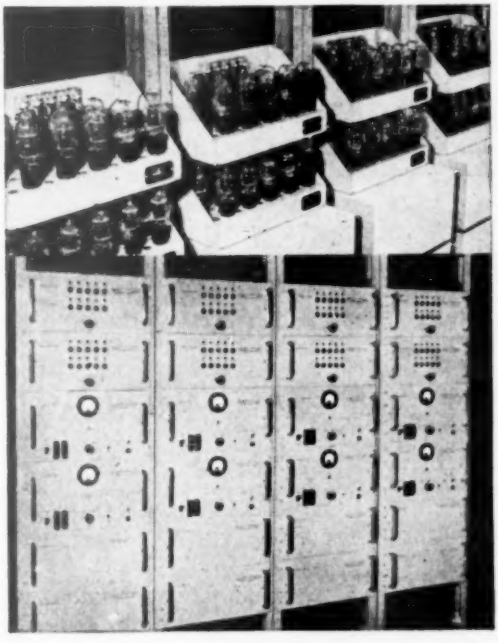

RATING

Heater Voltage (volts)	V_h	6.3
Heater Current (amps.)	I_h	1.6
Maximum Anode Voltage (volts)	$V_{a(max.)}$	800
Maximum Screen Voltage (volts)	$V_{g2(max.)}$	300
Maximum Control Grid Voltage	$V_{g1(max.)}$	—100
Maximum Voltage between g1 and g2 (volts)	$V_{g1\text{-}g2}$	400
Mutual Conductance (mA/V)	g_m	* 14
Maximum Anode Dissipation (watts)	p_a	35
Maximum Screen Dissipation (watts)	p_{g2}	5.0
Maximum Cathode Current (mA)	$I_{k(max.)}$	300
Maximum Potential Heater/Cathode (volts DC)	$V_{h\text{-}k(max.)}$	† 300

* Taken at $V_a = Vg2 = 150_V$ $I_a = 200$ mA.
† Provided the cathode is positive.
Base — International Octal.

LIST PRICE £2. 10s. 0d. (provisional)

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specify **'FREQUELEX'**

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3. **Permalex and Templex for Capacitors.**

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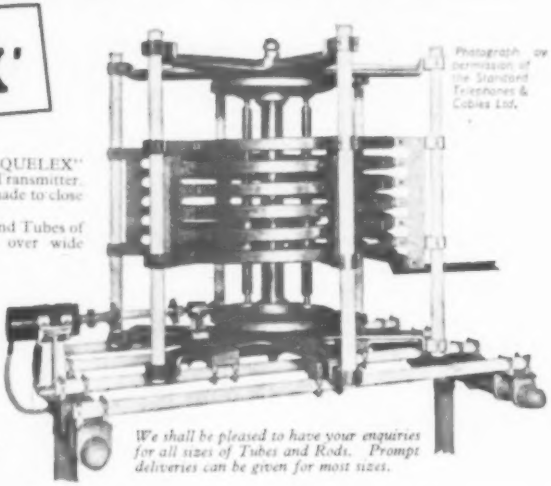
Large Rods up to 44" long and 1½" square are used as supports for Tuning Coils, etc.



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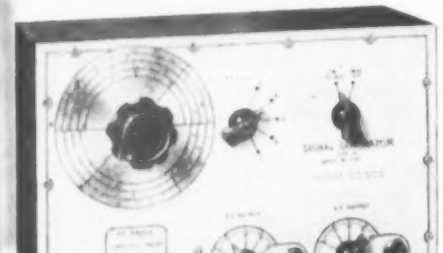

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Price £7 . 10 . 0

The accuracy, reliability and comprehensive specification, are some of the reasons why the TYPE 10 has achieved such outstanding success.

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New instruments now available include the HOMELAB CHECKTEST price £7 6d., and a range of accurately calibrated variable condensers, 100pf., 500pf., and 1000pf., price 42/- each.

Obtainable only direct from the manufacturers. Send for full technical details or call at address below.

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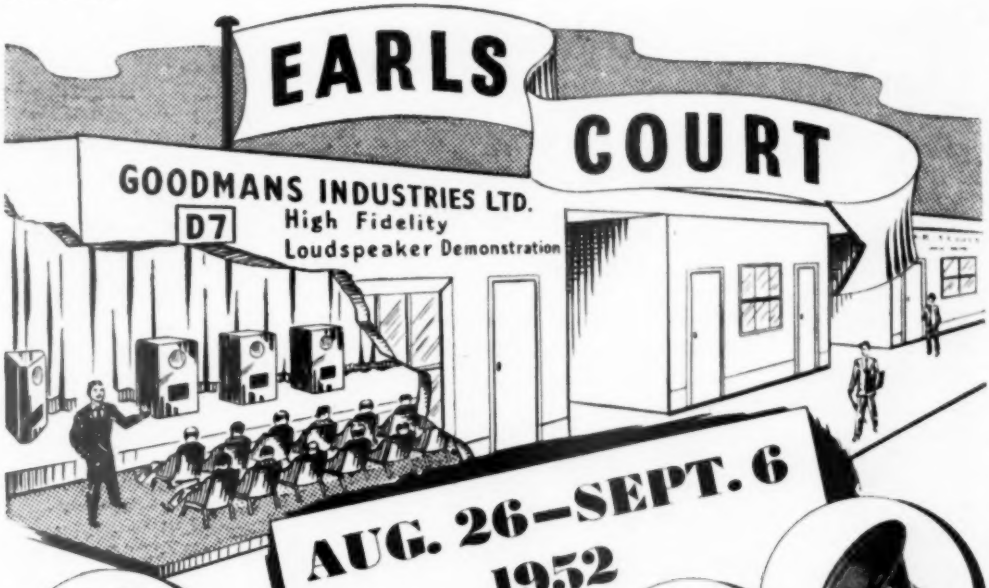

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A cold advertisement with its printed claims is all very well as an introduction to a product, but how much better a practical test of a manufactured characteristic.

Over 3,000 people passed through our demonstration room at the recent Northern Radio Show held in Manchester. At the end of each demonstration period we received a round of spontaneous applause denoting the obvious pleasure that good quality reproduction can afford to the receptive ear.

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Definitions

AXIOM

is a registered trade mark and denotes our High Fidelity Range of reproducers.

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is the registered trade mark that is applied to our good quality commercial reproducers.

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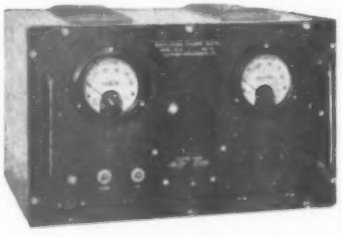

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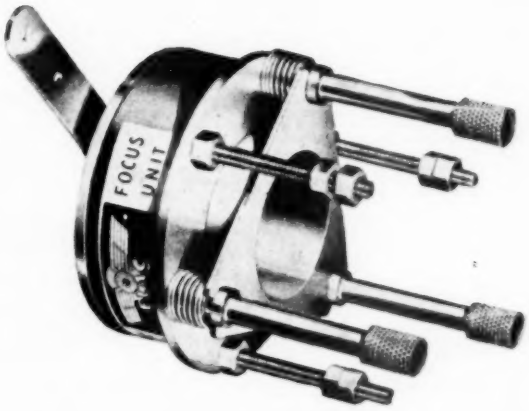

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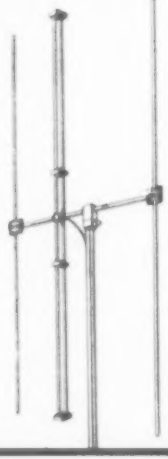

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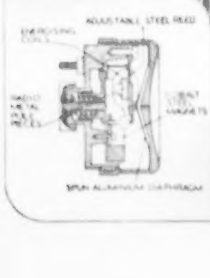

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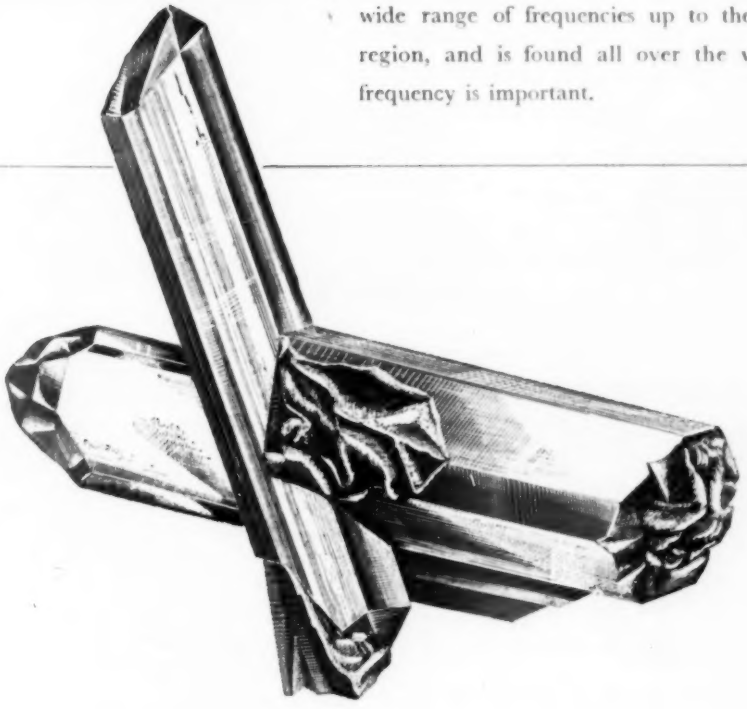

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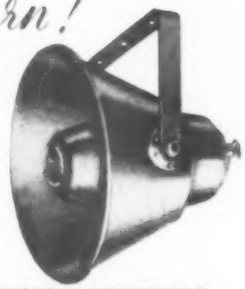

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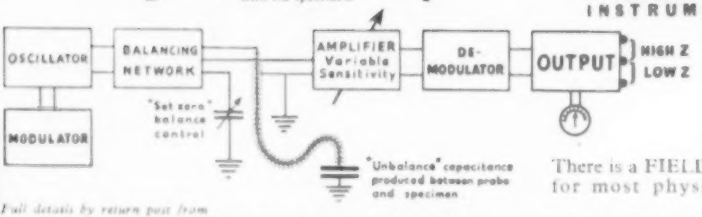

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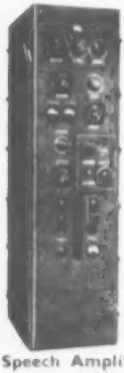

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Wireless World (rev ew) Jan. 1950

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I. Mair, FMTV (review) Oct. 1951. U.S. publication.

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Audio Engineering (review of 1951 Audio Conve tion in New York).

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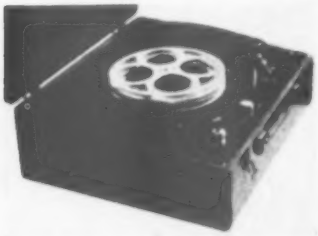

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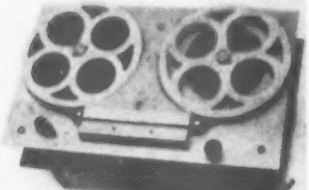

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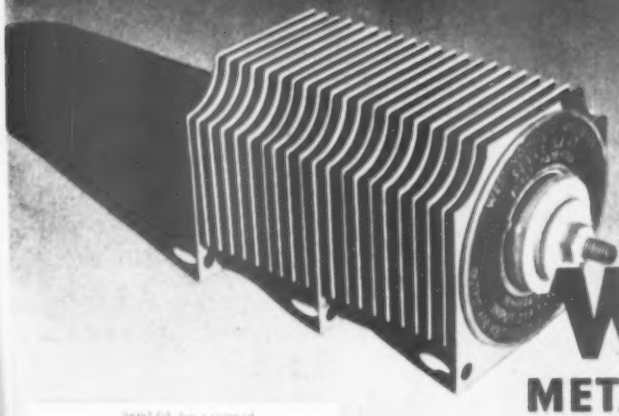

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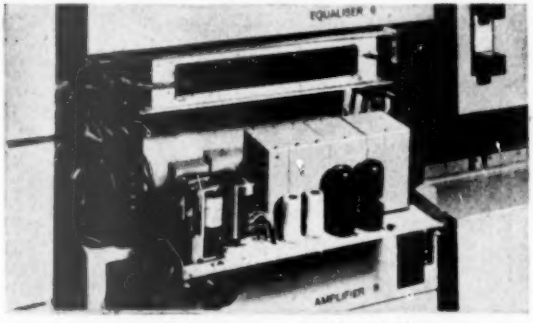
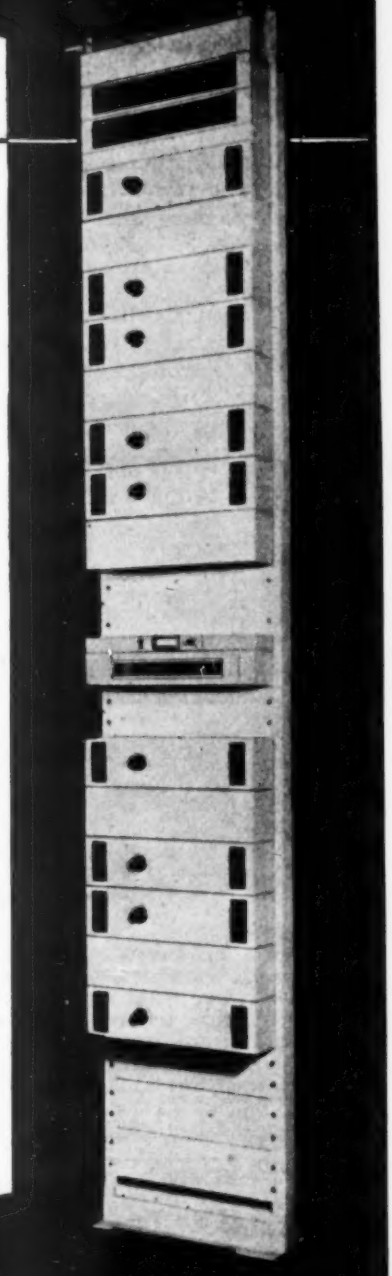


Above: Group amplifier
Right: Amplifier equipment bay



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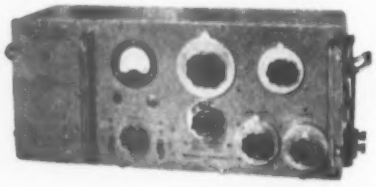

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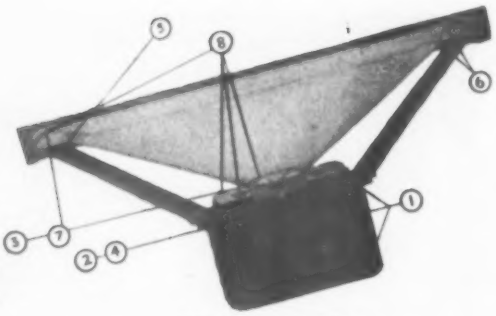

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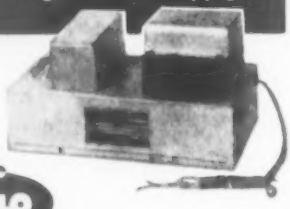

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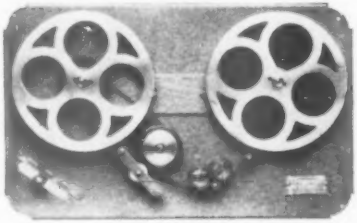

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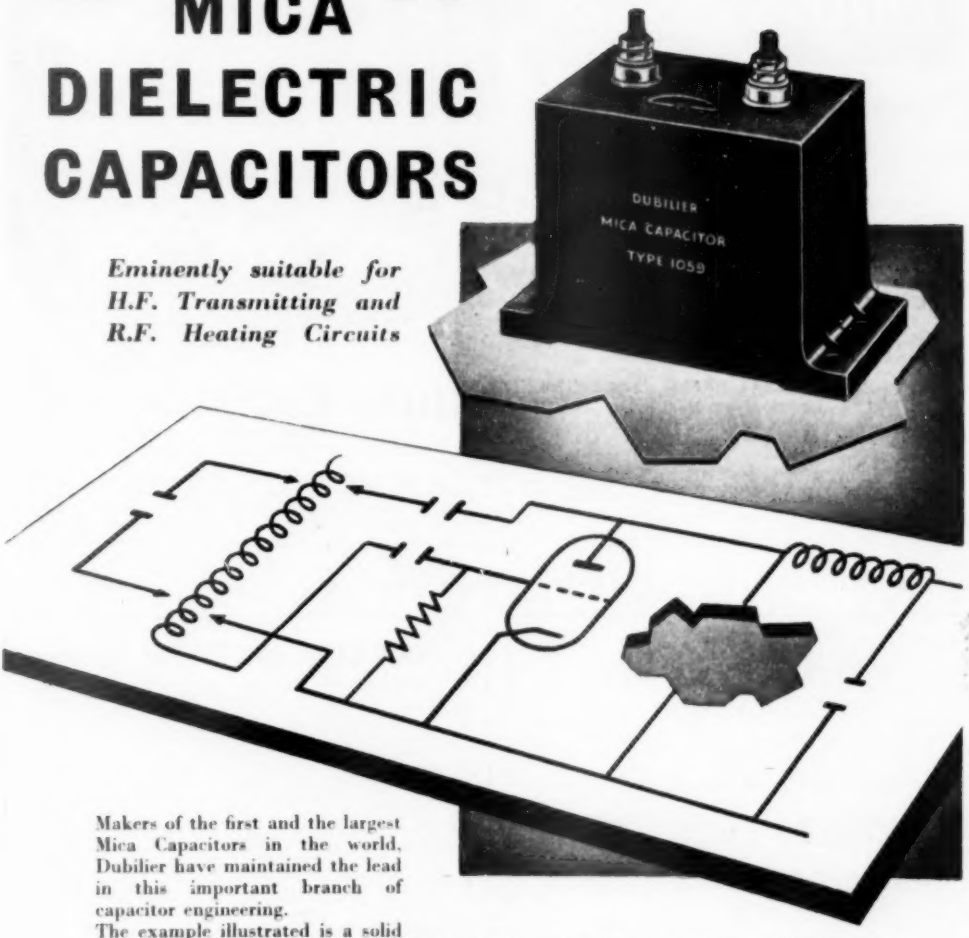

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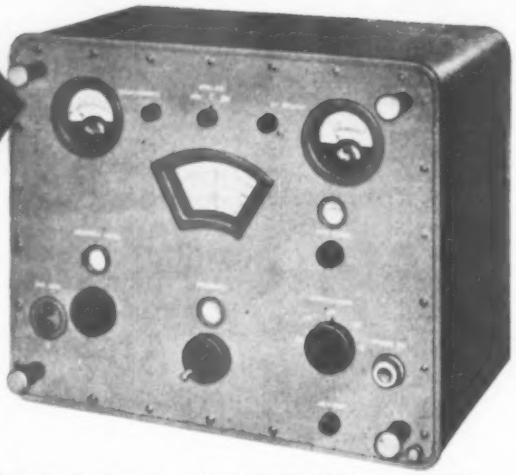

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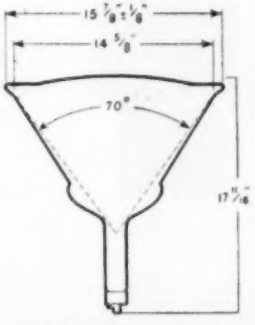
The metal C.R. tube has been specifically designed for use in cabinets which can be made substantially shallower in depth than has previously been possible with a 16" tube, which apart from other features shows a big saving in cost. The overall length of 17 11/16" is exceptionally short in relation to the large screen diameter and it will be found most convenient for easy component mounting. To sum up, it provides for big screen viewing in either table, console or radiogram cabinets of moderate proportions.



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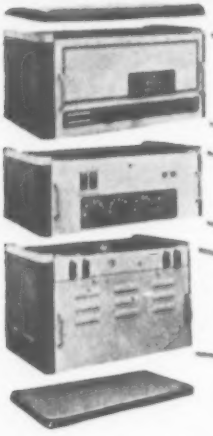

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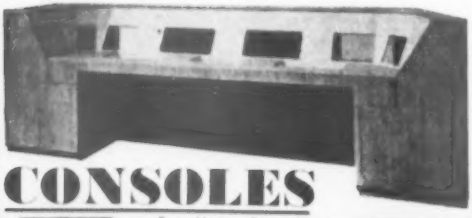

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The NEW PREMIER MAGNETIC TAPE RECORDING KIT

£29 · 8 · 0 ***Including ALL parts, Valves, Cabinet, Loudspeaker, Reel of Tape and Rewind Spool, but excluding Microphone.***

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The kit incorporates the *NEW MODEL* **LANE TAPE TABLE** already assembled and ready for use, a **6 VALVE SPECIALLY DESIGNED AMPLIFIER KIT including Bias and Erase Oscillator for use with the above unit, A REEL OF TAPE** and a **WELL MADE WALNUT FINISHED TABLE CABINET** to house the complete unit. Outside dimensions when closed : Height 13¾in., Length 17in., Depth 13¼in.

To those unable to build this TAPE RECORDER, we offer it built, tested, and ready to plug in, complete with Reel of "Scotch Boy" Tape, Rewind Spool, and RONETTE Microphone at

£36 : 10 : 0

(Packing, carriage and insur. £1.1.0.)

THE NEW **LANE TAPE TABLE**

SPECIFICATION :—

Made to high standards and incorporating features ensuring low level of "Wow" and "Flutter" throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run in less than 1 min. in either direction. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAY-BACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record play-back head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half track size allowing approx. 1 hr. playing from standard 1,200ft. Reel of Tape.

TAPE SPEED 7½in. sec. **For use on A.C. 200/250, 50 cycles mains only.**

SPECIAL FEATURES of the Amplifier include separate Bass and Treble lift controls, high and low gain input sockets, Record/Play-back indicator, etc. May be fed from Microphone, pick-up or directly from the Speaker terminals of your radio. Chassis size 14in. x 9in. x 2¼in.

The **AMPLIFIER KIT COMPLETE**

As is usual in all PREMIER KITS every single item down to the last nut and bolt is supplied. The chassis is punched and lay-out diagrams and theoretical circuits are included. When completed the **PREMIER** Tape Recorder compares favourably with all known makes.

EACH UNIT MAY BE PURCHASED — SEPARATELY —

PREMIER AMPLIFIER KIT, INCLUDING 8in. SPEAKER ... **£7.19.6**
2/6 packing and carriage.

PREMIER TABLE CABINET ... **£4.18.6**
5/- packing and carriage.

***NEW* LANE TAPE TABLE** ... **£16.10.0**
7/6 packing and carriage.

INSTRUCTIONAL BOOKLET 2/6
This is credited if a complete **Kit** of the **Tape Recorder** is ordered.

WORKING MODELS CAN BE SEEN AT THE ADDRESS BELOW

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NOW AVAILABLE IN THIS COUNTRY

We are proud to announce that we have obtained the Sole Agency for the Famous 'RONETTE' Filter Cell Ball Microphone. We confidently claim that the superb performance of this Crystal Microphone will amaze you.

PRICES—BALL TYPE **£3.19.6**
Table Stand for above **15.0**

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TORPEDO TYPE BII0
Crystal Microphone
£3.12.0
Table Stand
15.0

This is especially recommended for use with the Tape Recorder.

LUSTRAPHONE Moving Coil Microphones suitable for use with the Tape Recorder are available from stock. Prices : STAND TYPE, **£5 15 6**. Table Stand, **£2 12 6**. HAND MIKE, **£6 6 -**.

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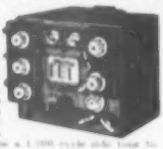
TRANSMITTER RECEIVER TYPE TR9M

Consists of Transmitter type T1196 and Receiver R1132 in one case. This is a 9-valve Battery operated Unit covering 1.5 Mc/s to 7.5 Mc/s. Crystal controlled complete with valves but less crystal. 50/-, plus 7/6 packing and postage.

EX-R.A.F. TRANSMITTER T1154 SERIES



A medium High Powered Transmitter for C.W. M.C.W. & Frequency Ranges 1·5-3 Mc/s, 3·5-7 Mc/s, 200-300 Kc/s. Tuning Mechanism is arranged so that predetermined frequencies can be set and returned to. Complete with 4 valves, 2 PT15 pentodes in parallel driven by an MLO in a series fed Hartley oscillatory circuit. A further MLO valve provides a 1,000 cycle side tone to enable the operator to log his transmissions on C.W. Price 39·6 plus 10/- Pkg. and Carr.

1124 RECEIVER UNIT

Range 30 to 40 Mc/s. Contains six new Valves 2/6SG, 1/6SL, 1/12DH (frequency changer), 1/6D7, 24 ceramic trimmers, 6 ceramic valve-holders, 6 valve screening cans, 30 resistors, 5 pot-meters, mica and tubular condensers, ceramic coil former, 3-way 4-bank switch with long spindle I.F. transformers etc. Brand new in maker's carton at 22·6 plus 5/6 postage and packing.

BRAND NEW R1155 RECEIVERS

In original cases, complete with 10 valves. Frequency range 1·5-7 Mc/s. S.-e. tuning. Internal modulator. £11 19·6 carr. paid.

POWER SUPPLY UNIT

for above, incorporating output stage. Provides an output of 250 volts at 80 m/a, which is ample for the R1155 with the output stage. Some gear for converting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6in. speaker is built into the unit. Price £5 5·-. Plus 5/- packing and carriage.

As a special offer, power supply unit including speaker together with R1155 receiver. PRICE £16.19.6. Plus 15/- pkg. & carr.

13 v. POWER SUPPLY UNIT and L.F. AMPLIFIER

A 13 v. vibrator power pack and amplifier combined. Unit produces 12 v. Mallory vibrator with filter components, 2 aluminium metal rectifiers, approximately 240 v. 30 m/a. 1-ATP4 valve, various chokes, transformers and a host of other useful components. Housed in a metal case measuring 11¼in. wide, 6¼in. deep, 4¼in. high. Price 29·6, plus 3/- Pkg. & Carr.

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We can supply all the parts to help you.

Ready Built Cabinet (Brown or Ivory)	17·6
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Punched chassis, 5 valve plus rectifier T.R.F.	3·9
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SEND 1·6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.

THE COMPLETE KIT

to construct a 5 valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at £6 9·6, plus 2/6 packing and carriage.

Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated and the Receiver housed in a Bakelite Cabinet size 12in. x 5in. x 8in. presents an attractive appearance. The valve line-up is:

6U7A—H.F. Pentode, VR116—Detector, APT4—Output, and Metal Rectifier.

Waveband coverage is for the medium and long bands. Choice of Walnut or Ivory coloured Cabinet.

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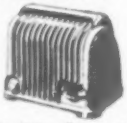

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Extremely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.

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Carrying handle incorporated in design. For use on 200-250 A.C./D.C. mains.

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Covered fully by Manufacturer's Guarantee

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Complete with 6Z4 Rectifier Valve, input 6-8 v. output 300 v. at 90 mA. The Unit is supplied with harness assembly incorporating fused battery leads, on-off switch and output plug. Price 42·6, plus 2/6 pkg. and carr.

BRAND NEW R1355 RECEIVERS

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Luminous dial, can be supplied with trip hands as illustrated or with plain glass front without trip hands. When ordering, please specify type required. Housed in strong black Bakelite casing. Panel mounting. Dimensions 3¼in. dia. dial. Fixing Panel 3¼in. sq. Projection 1¼in. from back. Price 42·6. Plus 1·6 post, pkg. ins.

2 STAGE QUALITY AMPLIFIER Complete with 10in. Energised LOUDSPEAKER

4 watts output. A.C. 110/230 mains.

£6.19.6 plus 5/- carriage.

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Balanced Armature Low Resistance Type 1, 5·11 pair; Type 2, 8·11 pair.

High Resistance 12·6 pair

Lightweight High Resistance 14·6 pair.

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Two specially designed chokes with three smoothing condensers with circuit diagram. Cuts out all mains noise. Can be assembled inside existing receiver. 6/- complete.

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An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and disc recording and sound projectors. Price 22·6.

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Wire ends, midget size. The ideal Crystal Detector. G.E.C. or B.T.H., 4·6.

METAL RECTIFIERS FULL WAVE

6 v. 1 amp., 4/-; 12 v. 1 amp. 8/-.

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Output: 650 v. 1 m/a. 4·7 each, 1,000 v. 1 m/a. 6/- each.

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By world-famous maker, 2 volt 10 amp. 4·11

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Complete with flex, lampholder and reflector. 25/-. Post and insurance 2/-.

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This is a 16-valve VHF Receiver incorporating a 30 Mc/s I.F. strip. Valve line-up: 2-CV66, 1-VU39, 2-EA50, 1-CV188, 1-VR137, 1-VU154, 8-EF50 valves. Price £4 2·6, plus 5/- pkg. and carr.

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This is a converted ex-Govt. unit, incorporating a 6V6 OUTPUT STAGE giving excellent reproduction on Gram. Complete in a metal case finished in grey enamel. Outside dimensions (approx.) 9in. long, 6¼in. high, 5in. deep. Price £5 10/-. Plus 5/- packing and carriage.

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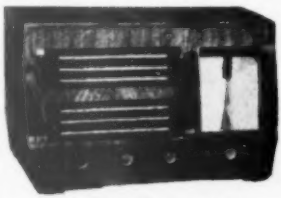
All parts to construct an eliminator to give an output of 120 volts at 20 m.a., and 2 volts to charge an accumulator. Uses metal rectifier. £2.

RADIO CABINET (WALNUT FINISH)

Outside dimensions: 14½in. high, 10½in. deep, 20in. wide



Price £2 2 6, plus 7/6 carr./pkg.

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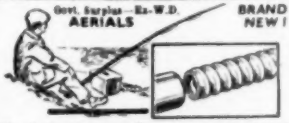

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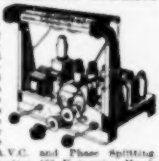

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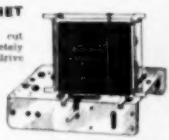

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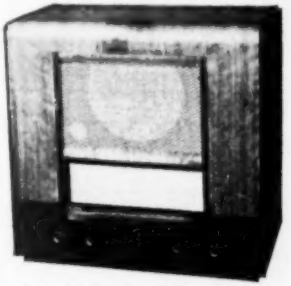

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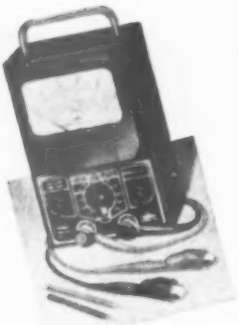

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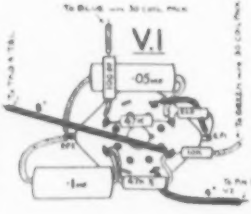

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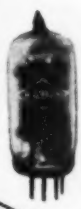

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6Q7GT 6R7 6R7G 6SA7 6SA7GT 6SC7 6SF5 6SF7 6SG7 6SH7 6SH7GT 6SJ7 6SJ7GT 6SJ7Y 6SK7 6SK7GT 6SL7 6SL7GT 6SN7GT 6SQ7 6SQ7GT 6SS7 6ST7 6U5G 6U7G 6V6 6V6G 6V6GT 6X4 6X5G 6X5GT 6Y6G 6Y7G 6Z5 7A4 7A7 7B6 7B7 7BP7 7C4 7C5 7C6 7C7 7E5 7E6 7E7 7H7 7Q7 7R7 7S7 7Y4 8D3 9D2 9D6 10 12A6 12A6GT 12AH7GT 17AT6

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47 50L6GT 50Y6GT 54 57 58 72 RX23S 75 76 77 78 80 81 82 83V 84 89 100TH 117L7GT 210VPT 211 (VT4C) 230B 250TH 262B 304TH 282A 304TH 307A 310A 311A 313C 323A 327A 328A 432BA 388A 394A 703A 705A 707A 708A 713A 714A 715A 715B 717A 724A 725A 726A 800 801 801A 803 805 807 808 813

811 813 814 815 826 828 829 829A 829B 830B 832 832A 833/833A 836 837 838 841 842 845 860 864 865 866A 866JR 869B 872 872A 874 876 923 931A 954 955 957 958A 959 991 1613 1616 1619 1622 1624 1625 1626 1629 1633 1642 1960 2051 4033A 7193 7475 8011 8012 8013A 8016 9001

9002 9003 9004 9005 9006 AR300 AR4101 ATP4 AUS (VU111) CL33 CMG25 CY32 D63 DA100 DET5 DET19 E1148/CV6 E1190 E1231 E1248 E1271 E1273 E1328 E1323 E1436 E150 EBC33 ECH32 EF36A EF22 EF39 EF50 EK32 EL32 EL33 GTIC GU20 HK54 HL2 H24 HP210 HP4101 HR210 KT24 KT44 KT61 KT66 KTW61 KTW62 KTW63 KTZ63 L30 LD210 LD410 LS5 MI1254 MH4 ML6 MR13 MSP4 NR65

MS PEN NC13 NC18 NGT5 NR50 NT63A NT99 OZ4 OZ4A PEN46 PM4DX PM202 PT15 PX4 PX25 R2 R3 R12 R82KA RK34 RK39 RK47 RK59 RKR73 RK75 RL7 RL37 RT20A S27A S130 SD6 SO12 SP2 SP4 SP41 SP210 SP15297 STV280/40 STV280/80 TT4/NR57 TZ20 TZ40 U12/U14 U18 U19 U23 VCU "C" VCU "N" VP23 VR53 VR90 VR150/30 VT98 VT595 VU39A VU120A VU133A VU504 Y63/61

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HALL ELECTRIC LTD

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use MUREX Sintered Permanent Magnets

A Murex Sintered Alcomax III Permanent Magnet operates the pointer through the solid body of the contents gauge, ensuring complete isolation of the dial from the liquid. A high degree of magnetic efficiency is required for this application, and as in many other applications, Murex Sintered Magnets continue to give accurate and reliable service.

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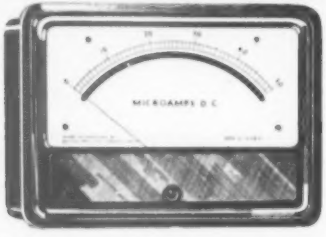
SENSITIVE PANEL MOUNTING METERS



SIZE	2½"	3½"	5"
RANGE	25μA to 50A	10μA to 50A	10μA to 50A

S.50 types microammeters are stocked by M.R. Supplies Ltd. at 68, New Oxford Street, W.C.1

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Universal Test Sets 1,000 and 20,000 Ohms/Volt.

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The ignorant are easy to live with; the educated even more so, but—against stupidity (Dummheit) *the gods themselves struggle in vain* (Goethe)."

However, **"Reproduction of Records"** is still available, price **3/11** post free.

J. H. BRIERLEY (Gramophones and Recordings) LTD.
KIRKBY TRADING ESTATE, LIVERPOOL

Sole Distributors for BURGOYNE MAGNETIC RECORDING HEADS 39/6 each Record-Playback or Erase

RADIO & TELEVISION ELECTRICAL APPLIANCES ELECTRIC TOOLS KITS

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TEST EQUIPMENT HI-FI REPRODUCTION TAPE RECORDERS AMPLIFIERS

Sole Distributors for BURGOYNE MAGNETIC RECORDING TAPE TABLES OSCILLATOR COILS, Etc.

The "BURGOYNE" MAGNETIC TAPE RECORDER KIT

A Kit of units enabling the enthusiast to build a Recorder at the lowest possible cost, comprising :—
(a) The Burgoyne Tape Table. (b) The Burgoyne Oscillator Unit.
(c) The Burgoyne Cabinet. (d) The M.O.S. Record Playback Amplifier.
(e) Sin. P.M. Speaker.

Also available ready for use **£31. 5s.** *(carr., pkg., 15/-)*
or £10. 10s. deposit and 12 monthly payments of 39/2.

Complete Kit **£27.5s.** (Carr., pkg. 15/-)
H.P. Terms: **£9. 5s.** DEPOSIT and 12 monthly payments of 34/6.
All units available separately as advertised. Instruction Manual 3/9 Post Free.

★ The BURGOYNE de Luxe Magnetic Tape Recorder Kit

£39 Complete. (Carr., pkg. 15/-) H.P. Terms: **£13** Deposit and 12 monthly payments of 47/6.
All units available separately as advertised. Instruction Manual 5/- Post Free.

For the Connoisseur of Magnetic Recording, we offer a kit comprising :
(a) The Burgoyne 14 valve Record Playback Amplifier.
(b) The Burgoyne Tape Table.
(c) The Burgoyne Cabinet.
(d) A Sin. P.M. Monitor Speaker.
THESE ARE NOT AVAILABLE AT PRESENT WITH WIRED UP AMPLIFIERS

RECOMMENDED ACCESSORIES : Scotch Boy or Emitape: 35/- per 1,200ft. spool; 21/- per 600ft. spool.

LUSTRAPHONE

MICROPHONES

Lustraphone have designed two models for use with Tape Recorders of all makes. Handsomely fashioned, both Table Stand Model CS1 and Hand Model CHS1 can be obtained in low or high impedance.

Model CS1

Model CHS1

MODEL CS1
Handsomely finished in Grey Wrinkle, can be mounted on Table Stand, Moulded or heavy cast base. On off switch fitted in case.

MODEL CHS1
Handsomely finished in Black Wrinkle with Chrome ribs. Specially designed Rotary Dual action switch fitted in case. 6 foot High-quality cable switch.

PRICES

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Model CS1 high impedance £5 15 6. H.P. : 45/6 deposit and 12 monthly payments of 9/2.
Type S2 Table Stand £2 12 6.
Type S2.B Heavy Table Base £1/1/-.
Type S2.MB Moulded Table Base 10/6.
Model CHS1 low impedance £5 15 6. H.P.: 45/6 deposit and 12 monthly payments of 9/2.
Model CHS1 high impedance £6 6/-. H.P.: 46/- deposit and 12 monthly payments of 10/-.

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FOR MAGNETIC RECORDING

FOUR-POLE TYPE FP10

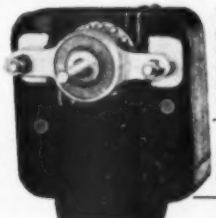
- Fully protected.
- Negligible external magnetic field.
- Oil impregnated self-aligning bearings.
- Silent running.
- Speed constancy.
- Both clockwise or anti-clockwise rotation available.

Voltage 100/125-200/250 A.C.; Consumption at 230 V. 14 watts; Speed (light) 1,400 R.P.M.; Max. and Starting Torque, 3 inch ozs. Shaft dia., .1875 inches; weight, 1¼ lbs.; size, 3⅛in. x 2⅜in. x 2¼in. External shaft length, 1in.

FP10 **38/-**

TWO-POLE TYPE SR1

●2,750 r.p.m. ●230 v. 50 c/s AC. ●Full load torque 3in. ozs. ●Weight 2¼ lbs. ●Will stand heavy overloads. ●Ideal for gramophones, motors, fans, switch movements, recorders etc. **32/-**



TWO-POLE TYPE SR2

- 2,750 r.p.m.
- Full load Torque 2in. ozs.
- Weight 1¼lb.
- 230 v. 50 c/s A.C.
- Ideal for motion displays timing mechanism, recorders etc.

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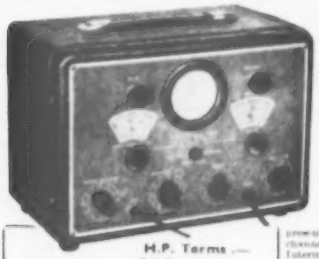

TAYLOR MODEL 260A TELEVISION WOBBULATOR

The First British instrument providing entirely self-contained visual alignment facilities for television receivers.

Carrier Frequency. From 5 to 70 Mc/s. This covers present and future television channels in addition to the usual Intermediate frequencies.

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Output Voltage. Adjustable from 0 to 10 mV. approx. Both fixed and variable attenuators are provided, the output impedance being 75 ohms.

Frequency Marker. A high order of frequency stability is ensured by the use of air spaced trimmers and highest grade components.

Range 1·11 to 18 Mc/s. Accuracy 1 per cent.
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Output Amplifier. The output voltage from a receiver is fed to a triode amplifier, thereby ensuring adequate height of trace on any type of receiver. **Weight.** 13½ lb. net. Dimensions 12½ × 9 × 9½. For operation from A.C. supplies 100-125 volts and 200-250 volts, 40-100 c.p.s.

CASH £36:15s. H.P. Terms — £12 DEPOSIT and 12 monthly payments of 66/-

To QUICKER TV SERVICING!

The *Radar* Kilovolter, *range* 3-30 Kv.

For measurement of line-flyback, RF and Pulse EHT Systems. The Radar Kilovolter has been introduced to meet the needs of the service engineer for an inexpensive instrument to measure the EHT voltage applied to the anode of television picture tubes including the higher voltages used with projection-type tubes. The Kilovolter consists essentially of a calibrated spark gap and no load is presented at the correct setting. Safe, reliable and fully guaranteed.

£3.17.6

PIFCO All-in-one RADIOMETER **29/6** Post free

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A pocket size 7-range instrument. 0-300 v. A.C. or D.C. in 4 ranges. 0-30 mA., A.C. or D.C. 0-300 mA., A.C. or D.C. 0-3 amp., A.C. or D.C. Precision built **50/-** Post paid

PLESSEY MULTI-SPEED AUTO CHANGERS

Cash price £23/13/0, or £7 deposit and 12 monthly payments of 31/6.

With every unit purchased for CASH we present a handsome walnut veneered playing desk (already mounted). An exclusive offer by M.O.S. for a limited period.

The COLLARO Series of AUTO-CHANGERS

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AUTOMATIC RECORD CHANGERS (use pick-up heads	Model RC521.600 or 611, auto-mixing changer for 78 r.p.m.	£9.16.1	£3.6.1	14/2
	Model RC 501 or 511, 3-speed version of above	£12.8.9	£4.3.9	17/2
	Model RC522, mixing version of above 10in., 12in. or 12in. intermix'd)	£14.19.0	£5	£1
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	*High fidelity low impedance	£1.19.4	—	—
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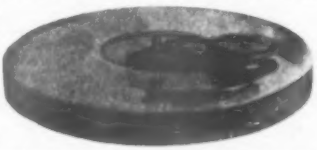
	High fidelity, Xtal GP27, 33⅓ r.p.m. (red)	£3.2.2	—	—
	High fidelity, Xtal GP27 dual-purpose	£3.2.2	—	—
	*Matching transformer for this head 7/-			
AUTOMATIC RECORD CHANGERS, COMPLETE WITH PICK-UP HEADS	RC521.611 with GP27 Head, 78 or 33⅓ r.p.m.	£12.18.3	£4.14.3	17/-
	RC511.511, with ordinary head	£11.16.9	£4	16/4
	1RC521 with GP27 high-fidelity head dual-purpose	£15.10.6	£5.3.6	£1.0.7
	1RC511, with two high-fidelity head 78 r.p.m. and 33⅓ r.p.m.	£13.12.8	£4.9	£1.5
	1RC522, with two heads, as above	£21	£7	£1.7

BSR 2-Speed GRAMOPHONE UNIT. Type MU10

- 33⅓ or 78 r.p.m. by reversing drive pulley.
- 10in. heavy pressed steel turntable.
- Ideal for use with any pick-up.
- Overall dimensions 10" × 10" × 4"



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BSR De Luxe Gramophone Unit. Type MU15

- Available for 78 r.p.m.
- 8in. diameter turntable.
- Ideal for portable record player.
- Ideal for use with any pick-up.
- Net weight 2 lbs.
- For use where space is a consideration.
- Overall dimensions 8" × 8" × 3"

£3.0.0 CASH

BSR

3-Speed Gramophone Unit Type GU4, with high fidelity light-weight Crystal Head.

★ 33⅓-45-78 r.p.m. speeds by switching ★ 4 pole induction motor ★ Transcription quality ★ Automatic stop ★ 10in. heavy pressed steel turntable fitted with removable rubber mat Overall dimensions 11" × 12" × 5. £9.19.11 Cash or H.P. Dep. £3.6.11 and 12 monthly payments of 14/5.

All other units advertised by BSR and carousels available from stock.

BSR TYPE MU14 3-SPEED MOTOR UNIT 78, 45 and 33 r.p.m.

● 10in. diameter heavy pressed steel turntable fitted on a precision ground taper steel spindle. ● Self lubricating bearings employed throughout, ensuring a long life of quiet running. ● Speed change from 78 to 45 or 33⅓ r.p.m. simply and instantaneously effected. ● No belts employed whatsoever. ● Incorporates the well-known BSR 4-pole motor. ● Instantaneous speed variation (wow), vibration and rumble at an absolute minimum. ● Uniform turntable speeds under widely varying loads. ● No stray field radiation noticeable with any type of pick-up. ● Ideal for use with any type of crystal or magnetic pick-up. ● Overall dimensions 12 × 10 × 9in. Motors are despatched connected for either 100-125 or 200-250 volts, 50 c/s., but change from one voltage range to another is accomplished easily.

CASH **£6.8.6**

Hire Purchase Terms

£2.3.0 deposit

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NEW FULL VISION DRIVE ASSEMBLY

Vertical dial with new station markings on S., M. and L. wave bands (3 colours). Size of dial approx. 5in. by 7in. in "Perspex" with back illumination plate. Drive mechanism absolutely positive and non-slip, with nylon cord. Complete with assembly instructions. Post free. **21/-**

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Now available to the small user in kit form.

HELLERMANN TOOL KIT Type TK2

17/6 each Post and packing 1/-

Contains a complete range of components as follows: 1 Type TL Tool, 1 Bottle Hellerine Lubricant, an assortment of genuine Hellermann Rubber Sleeves in red and black, Hellermann Cable markers printed "Earth."

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H.P.: Send deposit with order which will be dispatched upon signing H.P. Agreement.

CASH: Cash with order or C.O.D. if goods suitable for post

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BURGOYNE SOLDER GUN
7/6
Spare bits 10 for 7/6.

Profitable Pleasure

for all Home Constructors, Handymen, Model Makers

WOLF Cub HOME CONSTRUCTOR EQUIPMENT

Wolf Cub Drilling, Grinding and Polishing Kit consists of :—

1 Wolf Cub Drill	£5 10 0	
1 Wolf Cub Bench Clamp	18 9	
1 Drilling, Grinding, Polishing Set No. 3	£1 7 0	**£7.17.9**

Wolf Cub Sanding, Buffing, Polishing Kit consists of :

1 Wolf Cub Drill	£5 10 0	
1 Sanding, Buffing Set No. 4	£1 6 0	**£6.16.0**

Wolf Cub Drill Stand consists of :

1 Wolf Cub Drill	£5 10 0	
1 Wolf Cub Bench Clamp	18 9	
1 Drill Stand Base Set No. 1	£1 14 9	**£8.11.9**
1 Drill Stand Pillar No. 2	6 3	

Wolf Cub Electric Lathe Kit consists of :

1 Wolf Cub Drill	£5 10 0	
1 Bench Clamp	18 9	
1 Drill Stand Base Set No. 1	£1 14 9	**£9. 8. 3**
1 Drill Stand Pillar No. 2	6 3	
1 Lathe Set No. 4	16 6	

Wolf Cub Electric Saw Kit consists of :

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1 Bench Clamp	18 9	
1 Drill Stand Pillar No. 2	6 3	**£9. 12. 3**
1 Saw Set No. 5	£2 17 3	

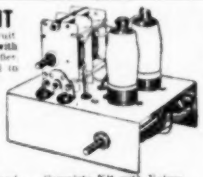
M.O.S. RFI RADIO FEEDER UNIT

This tuning unit uses a straight TRF circuit tuning the Medium Wave Band. **It provided with its own power unit,** it can be used with any amplifier. The unit is exceptionally sensitive, can be used in areas of only moderate signal strength.

By use of a TRF circuit the bandpass is such that the output fed into an amplifier is of very high fidelity, and full advantage can be taken of the transmitted quality.

The unit is provided with only two controls—Tuning and Sensitivity—and consequently is very simple to operate. No tuning scale is provided as it is thought that the great majority of constructors will prefer to fit the unit into a cabinet and so be able to choose an assembly to suit the housing. Adequate spindle length is provided in all cases.

In line with others in the "Easy-to-Build" series, kit is complete in every detail, and instruction manual fully detailed and illustrated.



Complete Kit with Valves £2 12 6
Instruction Manual only 2 0
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Amplion has marketed one of the most important developments in the field of dry batteries. A mains unit has been specially designed to increase their life. It is only too well known that the useful life of a dry battery is limited, dependent upon the consumption and, to a great extent, on the number of successive hours of use.

With the aid of the Amplion Activette the users of dry batteries will be able to extend the usual life of a dry battery by three to six times consumption of the Amplion Activette being approximately 3 watts.

Input 200/250 v. A.C. Suitable for all radio dry batteries with H.T. from 45 to 90 v. and L.T. 1.4 v. Fitted with three tappings to suit different H.T. batteries of 45, 67 and 69, and 90 v. Output socket a standard 4-pin (miniature). Size 4¼in. × 2¼in. × 1¼in. Weight approx. 1 lb. **£3. 5. 0**

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HARTLEY-TURNER TYPE 215

This speaker is now recognised by musical connoisseurs throughout the world as giving the closest approach to realism in reproduction that has yet been achieved at any price level—judged on a basis of freedom from distortion, complete freedom from cross modulation (the diaphragm can be moved half an inch by a sub-audible frequency and no modulation of a simultaneously applied high frequency note will be heard), uniformity of sound propagation and entire absence of bass resonance. It will more than hold its own with speakers costing fifteen times as much.

Peak handling capacity, 30 watts. Flux density, 11,500 lines sq. cm. Maximum diameter, 10in. Maximum depth, 6in. Baffle hole, 8in. Diameter. Net weight, 6½ lb.

Voice coil 4 ohms only.

£14 : 10 cash

Hire Purchase Terms :— £4 10 deposit and 12 monthly payments of £1.

For EFFICIENCY plus RELIABILITY

you must have a

BURGOYNE AERIAL CO-AXIAL CONNECTOR

This is the ONE and ONLY unit available which enables a really efficient and reliable weatherproof connection to be made between a dipole and its feeder.

Each connector in carton with full assembly instructions. **24/6** **As supplied to Marine and Colonial Govt. Depts.**

DISTRIBUTED EXCLUSIVELY BY M.O.S.

NOW AVAILABLE

BARKER NATURAL SOUND REPRODUCERS

DUAL DRIVE WITH BUILT-IN CROSS-OVER AND FEEDBACK

Barker Sound Units give the full audio-frequency range with absolute smoothness and continuity, plus unique clarity and detail.

★ **A dual drive consisting of a very light metal tube on which is wound a coil of fine wire over a skin of pure long life latex.**

★ **A cone impregnated with a new cellulose and moulded with logarithmically graded corrugations from apex to rim.**

SPECIFICATION

	Model 148a	Model 150
Overall diameter	12¼in.	12¼in.
Cone diameter	10in.	10in.
Baffle opening diameter	11in.	11in.
Overall depth	7in.	8in.
Magnetic field intensity	14,500 g.	17,500 g.
Coil impedance	15 ohms	15 ohms
Maximum peak input	15 watts	15 watts
Weight (net)	8¼ lb.	16½ lb

Fixing: Both models 4 equally spaced holes on 11¼ dia. circle.

Model 148a: 15 gns. Hire Purchase: £5.5s. deposit and 12 monthly payments of 21/-

Model 150: 18 gns. Hire Purchase: £6.6s. deposit and 12 monthly payments of 24/6.

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EVERYTHING REDUCED BY 10%

(EXCLUDING VALVES AND PURCHASE TAX)

FOR TWO WEEKS ONLY

AUGUST 5TH TO 16TH

The "RD JUNIOR" PRE-AMPLIFIER

(Incorporating Low-pass Filter)

An entirely new design with a high performance and wide range of application. Primarily intended for use with the new "Junior" amplifier and the "Baby" amplifier, it may be used with the latter without modification.

MAIN FEATURES

- ★ High input sensitivity. MIC 8 m/V. P.U. 40-60 m/V.
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- ★ Wide range switched bass and treble controls.
- ★ A low pass filter operating at 7 kcs. and giving 40 DB per octave attenuation.
- ★ Bass lift response ideally suited to low level listening requirements.

PRICES

Pre-amplifier complete with engraved panel	£8 10 0
"RD Junior De-Luxe" amplifier and new pre-amplifier	£28 10 0
"RD Baby De-Luxe" amplifier and new pre-amplifier	£21 0 0

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SILVER PREPARATIONS *for* METALLIZING MICA and CERAMIC CONDENSERS

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Owing to over-production these slightly factory soiled figured Walnut Radio Cabinets can be offered at a bargain price. Manufactured for £3.17.6.

Our Price 35/- Incl. P.T.

Can be bough, singly or in quantities, and can be adapted for all Mains or Battery units. Post and packaging 2/- each 12 or over, carriage paid.

Interior size
19¾ x 12¾ x 6¾in.

CARLTON CABINET WORKS (LONDON) LTD.

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Good Points of Superspeed ACTIVATED COLOURED ROSIN CORED SOLDER

- Coloured Core provides coloured rosin residue for ready identification.
- Choice of red, blue, green, purple or yellow core.
- Stellate Core cross-section for quick melting and fluxing.
- Activated Rosin Core for fast working and absence of corrosion.
- Identical—except for colour—with the famous Superspeed White Flash Cored Solder.
- Residue solidifies to a hard, semi-translucent film of high dielectric strength.

Let us send you full technical details of the new Coloured-core Solder.

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FIRST
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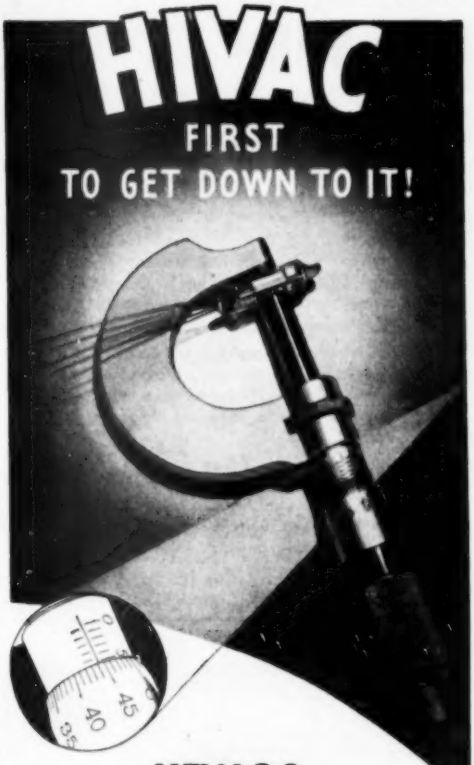

XFW 30

Beam Tetrode Subminiature Amplifier

TYPICAL OPERATION

Filament Voltage	**0.625v**
Filament Current	**12½mA**
H.T. Supply Voltage	**22½v**
Anode Load	**1 to 2MΩ**
Screen Resistance	**3MΩ**
Stage Gain	**32**

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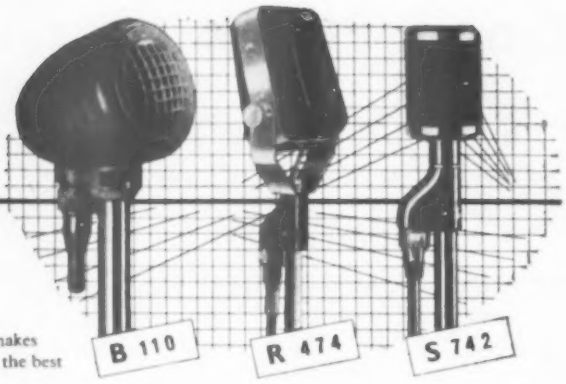

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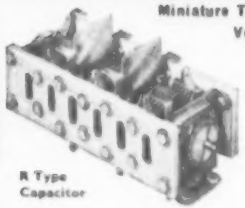

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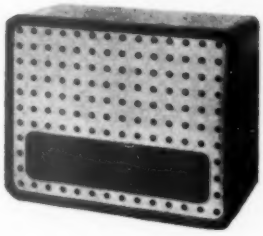

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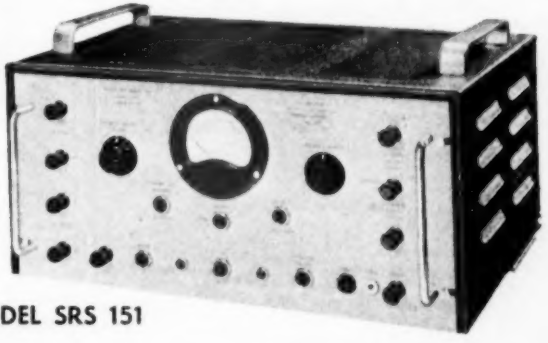

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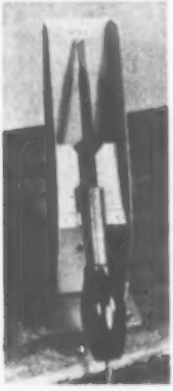

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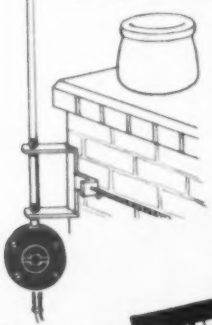

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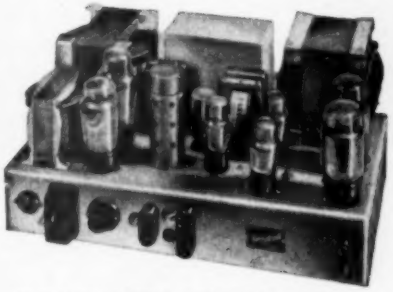

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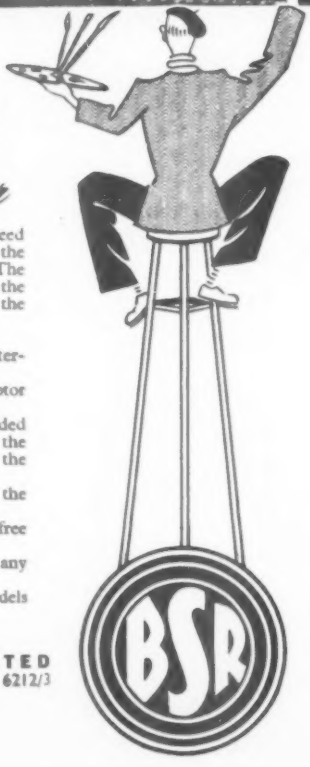

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

42nd YEAR OF PUBLICATION

Managing Editor : HUGH S. POCOCK, M.I.E.E.
Editor : H. F. SMITH

AUGUST 1952

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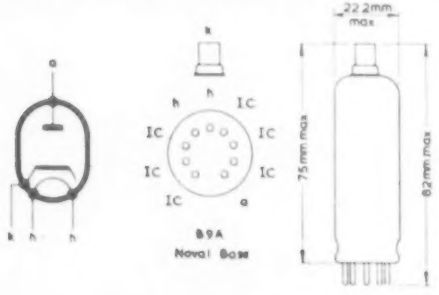
Owing to the thicker heater insulation, however, the cathode heating time of the PY81 is approximately twice that of the PY80, and this may call for special precautions to safeguard certain valves in the set during the period immediately after switching on.

These are the valves the anodes of which are fed from the boosted H.T. line and the screen grids from the normal H.T. line. This usually applies only to the line output valve, Type PL81.

This stage is, of course, so designed that, with the boosted voltage applied to the anode and the normal H.T. potential applied to the screen, the specified maximum dissipations are not exceeded.

On switching on, however, the normal potential will be applied to the screen grid before the booster diode comes into full operation and the anode voltage reaches the boosted value, and during this period the screen dissipation of the valves concerned may be exceeded.

It is possible, however, so to arrange the circuit that this over-run is limited, both in extent and in duration, to a figure which the valve will safely withstand.



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V_h	17 V

Capacitances

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Limiting Values

† P.I.V.	4,500 V
$I_{k\,(pk)}$ max.	450 mA
$I_{k\,(av)}$ max.	150 mA
* $V_{h-k\,(pk)}$ max. (heater negative)	4,500V

† Max. pulse duration 18% of one cycle with a maximum of 18μ secs.

* The voltage between heater and cathode during the forward stroke of the scan must not exceed 600 V when the mains voltage applied to the heater chain is at its maximum negative excursion.

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Wireless World

AUGUST 1952 VOL. LVIII. No. 8

Castles in the Air

AFTER protracted Parliamentary debates, the future of the B.B.C., which has so long hung in the balance, was settled on the day before our last issue appeared. Thus we have had plenty of time to think about it, and our thoughts are not predominantly pleasant ones.

The main changes introduced into the B.B.C. charter, licence and agreement are set out on another page. We may say at once that few of them hold much interest for us or our readers. The only change to which much significance can be attached is the superficially trivial addition consisting in the qualification of the word "licence" by the adjective "non-exclusive." This means, as the public has been told by Government spokesmen, that the B.B.C. may lose part of its monopoly; at some rather vague but not too remote date, Parliament may allow the Postmaster General to grant a licence for an independent television service, financed not from licence revenue but from advertisements. Sound broadcasting, including v.h.f., remains a B.B.C. monopoly.

If only from motives of self-interest, every wireless man would welcome an additional television service, however brought about and however financed. But, to us at least, the Government's proposals, in spite of protests to the contrary, lack the air of reality, and it is hard to visualize the setting up of a competitive service in the foreseeable future. And, if this view be wrong, any benefits that might accrue from it are likely to be offset by the fact that broadcasting has been made a party-political issue. That was contrary to the wishes and hopes of most of us. The Radio Industry Council—wisely, we think—conducted an energetic campaign to prevent this very thing from happening. Now we stand to get the worst of both worlds; sponsored television may not arrive, but the threat of it may hamper development.

Let us consider all the things that must happen before the first sponsored television transmission can be radiated. We have few facts to work on, but will base our speculations strictly on official documents or on the pronouncements of Government spokesmen. The sponsored stations are to work on higher frequencies, but, by implication, on the existing standards of definition. The B.B.C. must complete its (interrupted) present scheme for television and also get v.h.f. sound broadcasting at least under way before sponsored television can start. But first the Television Advisory Committee, now charged with responsibility for v.h.f. as well, must advise the P.M.G. on the conditions for the v.h.f. sound service before turning to sponsored television. T.A.C. has not met for a year, and may be a slow starter.

These preliminaries being disposed of, the licensing of sponsored television stations must be debated by Parliament. Presumably the measure will be even more hotly opposed than was the insertion of "non-exclusive licences" into the B.B.C. charter. And what kind of organization can apply for licences? All we have to go on is the White Paper, which mentions "bodies or persons." Is the plural deliberately chosen, indicating that the Government does not intend to create another monopoly? Is the only precedent we have—that of the original British Broadcasting *Company*, financed by leading radio manufacturers—to be followed? *Wireless World* can obtain no confirmation or denial of these ideas. A unified organization, able ultimately to offer national coverage, would, we assume, be most favoured by the big advertisers who would be its main supporters. If the right to conduct sponsored television is in fact so valuable, one can foresee the most intense competition for the privilege, with more delay.

But, after all, will the business world have enough confidence in sponsored television to ignore the declared intention of the Parliamentary Opposition "not to carry on" the policy of the present Government? There can be few less valuable assets than a television station without a licence.

To ask more questions would be to labour the point that the Government scheme can hardly be more than, at best, a project for the dim and distant future. More realistic means must be found to foster the development of television, and if need be, to test the possibilities of advertising programmes. Fortunately, nothing more has been done legislatively than the timid insertion of "non-exclusive" into the B.B.C. charter, and, as the Home Secretary tells us, all earlier charters were non-exclusive anyway, though not so labelled. Therefore the ill-conceived project can be gracefully dropped, or forgotten, without too much embarrassment.

Calculating Transient Response

Simplified Derivation from Frequency and Phase Characteristics

By THOMAS RODDAM

MACBETH, crossing a blasted heath, was not surprised to encounter three witches brewing up: nowadays he would expect to find a rather worn-looking mansion filled with engineers muttering: "When the mu-beta comes to one-nought, beware, beware!" There they sit, adding more and more feedback round more and more loops, and as the amplifiers get more linear, new troubles appear on the horizon. One of these is a problem which has long been discussed; when you talk about 0.1 per cent. harmonic distortion, which harmonic? If you don't think it matters let me just remind you that you can hear a 1,000-c/s tone which is 36db lower than the quietest 100-c/s tone you can hear, so that 0.1 per cent. of 20th harmonic of 50 c/s is as audible as about 6 per cent. of second harmonic. As you know, feedback amplifiers tend to produce these higher harmonics in the overload region—in fact that is the only way you know that they are overloaded. The other problem is that of transient response.

There is an enormous amount of nonsense written about transient response, especially as it affects the loudspeaker. Broadcast programmes are amplified, piped round the country and re-amplified. In the course of this process, every effort is made to keep the frequency response flat, up to 10 kc/s, or whatever the frequency is. Above this, transformer after transformer provides a 12 db octave cut-off. So what can you do, chum?

Transient response is important though for three reasons: television, of course, in servo amplifiers and in amplifiers in tandem. The first two applications are fairly obvious, but the third deserves a fuller explanation. Suppose that we are operating two amplifiers, one driving the other: this is quite a common situation, for one may be a microphone amplifier and the other a power amplifier. If the first amplifier produces a large, though very short, overshoot there is no direct audible effect, because the frequencies in the transient peak are above the limit of hearing. This peak may, however, drive some stage of the power amplifier into grid current, and the stage may then be held at an improper bias by the grid CR network for an appreciable time. During this time, perhaps 1/10th of a second, the stage will produce more distortion than usual, and as the gain has been driven down, the feedback will be less effective than normal: muddy transients are the result.

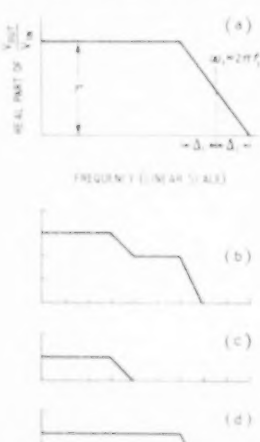


Fig. 1. (a) Basic trapezoidal response which gives the transient response shown in Fig. 2. The more complicated response in (b) may be resolved into the two trapezoidal responses shown in (c) and (d).

It need not be two amplifiers in two boxes for this effect to be apparent. A single multistage amplifier with a transformer in the middle, or perhaps with the feedback arranged in two separate loops can cause trouble of this kind. As our amplifier designs get more and more sophisticated we need to watch out for more and more of these obscure effects.

Circumventing Laplace

The obvious thing for the conscientious designer to do is to calculate the transient response, just as he calculates the frequency response of a feedback amplifier before he starts. Very few designers do this, because they imagine they will be confronted by an immense formula to be fed into the Laplace Transform machine. If this were the only way of studying transient response they would—to use an Antipodean phrase—be too right. Fortunately G. F. Floyd, of the Massachussetts Institute of Technology, has described in a thesis* a simpler way of dealing with the problem. Floyd's method, dehydrated and predigested and generally made fit for engineers' consumption, is the subject to reason about to-day.

First of all we need to know the frequency response and phase characteristic of the amplifier. In all the discussion which follows I propose to treat only the transient due to the high-frequency cut-off, and not the droop due to lack of low-frequency response. I shall, however, comment on the application of the method to "droop" calculation at the end of the article. But back to our frequency response. If you have read any of the papers or books† on the connection between response in time and frequency response you may have noticed that the decibel and the logarithmic frequency scale are not used. We use these logarithmic units for convenience, and because our ears are fairly logarithmic in performance. When considering transient response we start off with a very

* See also "Principles of Servomechanisms" by G. S. Brown and D. P. Campbell, published by Chapman & Hall.

† For example, "Radio Engineers' Handbook" by F. E. Terman, published by McGraw Hill, p. 968 et seq.

artificial signal and examine how the energy it contains gets redistributed in time, and the energy in one frequency band is as important as that in the neighbouring bands. We must therefore be prepared to draw our frequency response in terms of actual magnification with a linear frequency scale.

There are two separate meanings attached to the term "transient response." To some people it means the response to a square-wave input, while to others it means the response to a very short impulse. Between the two there is, of course, a very close mathematical connection, and it is largely a matter of practical convenience which is used. I prefer to use a short impulse for test purposes, because it is then so easy to recognize the unwanted "ringing" which appears as a train of damped oscillations after the main impulse. In some special circumstances, however, square waves provide much more information: for example, I have arranged amplifiers so that they were unstable on the "swing" of a square wave and stable on the "swong." On the oscilloscope the unstable condition was shown by a growing oscillation on one half of the cycle, followed by a decaying oscillation on the other half. This sort of behaviour corresponds to those bursts of high-frequency oscillation at the low-frequency peaks, which produce such an unpleasant sound and are rather difficult to detect without very full tests.

For the purpose of this article, transient response will be taken as the response to a very short impulse. The method of calculating it depends on a basic theorem, the truth of which we assume in almost all our electrical theory. That theorem is the Superposition Theorem, which states, though not in these words, that two happenings in a linear system go on quite independently of each other. To calculate the transient response we first of all imagine a circuit having a particular frequency response for which the transient response is easily calculated. We then pretend that the actual circuit is made up of a number of these ideal systems in parallel, having different factors in their make-up. Each system passes a transient of the standard type of a particular size and time scale. Then we add all the transient voltages at any instant together. An example will make this clearer.

The standard frequency response, which is called, for reasons which will follow, the "real part" response, is shown in Fig. 1(a). The transient response of an amplifier (or any other network) having this frequency response is shown in Fig.2. Suppose that we find that our amplifier has a response like that shown in Fig. 1(b). We imagine it to be made up from two units, one having the response of Fig. 1(c) and one having the response of Fig. 1(d). We take two curves of the form of Fig. 2 with the appropriate scales, add them, and there is the final transient response of the system.

"Real Part" Response

We must now begin to clothe these bare bones. As I said above, we use a frequency response known as the real part response. This is the graph of $m \cos \theta$, where m is the voltage gain and θ the phase shift between input and output. For calculation purposes this is a great nuisance, because if you are using graphical methods of predicting the frequency response you are working with decibels and a logarithmic frequency scale.

The stages in the determination of the real part response can be followed in Fig. 3. The basic response

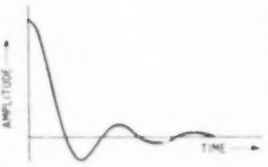


Fig. 2. Response to a single short impulse of a circuit with the frequency response of Fig. 1 (a).

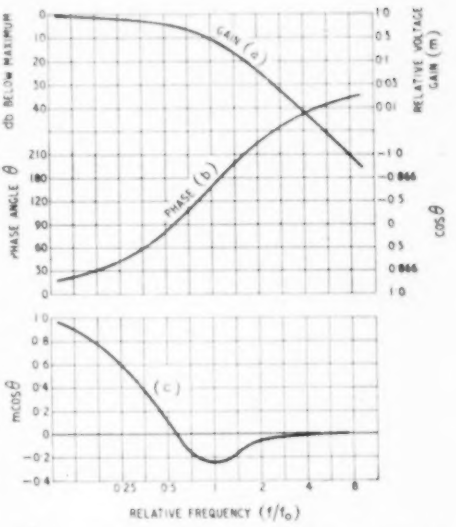


Fig. 3. From the gain and phase to characteristics (a) and (b), the real part response (c) is calculated. Frequencies are plotted on an octave (log) scale.

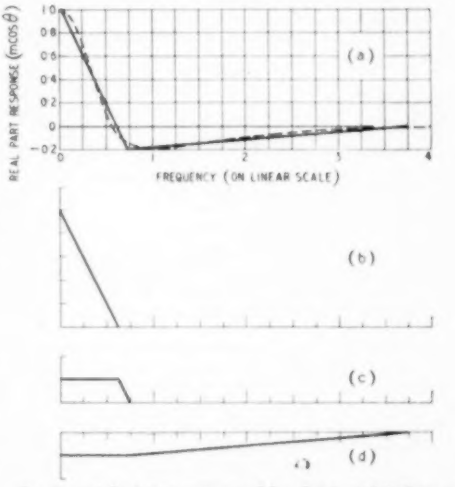


Fig. 4. (a) Real part response of Fig. 3 (c) replotted to a linear frequency scale with superimposed straight-line approximation. (b) (c) and (d) Trapezoidal responses which added together give the straight line approximation of (a).

curves, frequency response in decibels, and the phase characteristic, are shown at (a) and (b). The frequency scale here is an octave scale, which for all theoretical purposes is just as good as a logarithmic scale of the ordinary kind, in fact you can mark a logarithmic scale in on the paper. For practical purposes, however, it is very much better, because it uses ordinary centimetre square paper, which is cheaper and is always available. It is painfully surprising how often in a large organization the 3-decade log paper runs out, and you have to make do with 2-decade or 4-decade. And if you have standard curve shapes, they just don't fit the paper.

In addition to the decibel and angle scales I have marked in the voltage ratio, m, and cos θ scales. At each convenient frequency we take (voltage ratio) $\times$ (cos θ) to get the real part (RP) response plotted in Fig. 3(c). This RP response is still plotted on an octave frequency scale, and it must be replotted on a linear frequency scale before we can use it. This has been done in Fig. 4(a), which shows clearly how the logarithmic frequency scale tends to minimize the very important high-frequency behaviour.

The solid line segment response shown in Fig. 4(a) is the approximate form which is used for calculating the transient response. It is not too difficult to see that this can be represented as the sum of the three RP responses shown as Figs. 4(b), (c), (d), which are all of the standard trapezoidal form. All we need to do now is to take the transient response corresponding to each trapezium and add them together (that for (d) of course, must be subtracted).

At this point we introduce the essential formula. With the terms defined in Fig. 1(a), the transient response of a system having a trapezoidal real part characteristic is given by the equation

$$h(t) = \frac{2r}{\pi} \cdot \omega_1 \left(\frac{\sin \omega_1 t}{\omega_1 t}\right) \left(\frac{\sin J_1 t}{J_1 t}\right)$$

whatever you do about it, this formula involves quite a lot of arithmetic. The linear is simplified by making use of a table or graph of the function $(\sin x/x)$. I have produced a graph of this function, and it is given at Fig. 5. For each trapezium we then make a table of the form shown:

TABLE

Trapezium 1:

r ω_1 =

$\frac{2r}{\pi}$ J_1 =

t	$\omega_1 t$	$J_1 t$	$\frac{\sin \omega_1 t}{\omega_1 t}$	$\frac{\sin J_1 t}{J_1 t}$	h(t)
0					
1·10,000			from Fig. 5		
2·10,000					
etc.					

We then transfer the last column to a new table, in which the transient responses for the separate trapezium are collected. Adding the response for each time we have the total transient response: $h(t) = h_1(t) + h_2(t) + \ldots\ldots$

Kronecker, who introduced the delta function, a kind of unit impulse, into analysis, says somewhere: "God made the integer; the rest is the work of man." He could have hardly been more right about this particular impulse problem, because the average network transient response takes about a page full of closely written figures. But it is only slide rule work and addition, there is no real mathematics to it. I have not carried through the calculation of the transient response for one example: it would make an impressive looking page, but I do not think the Editor really likes to publish a page of dull arithmetic.

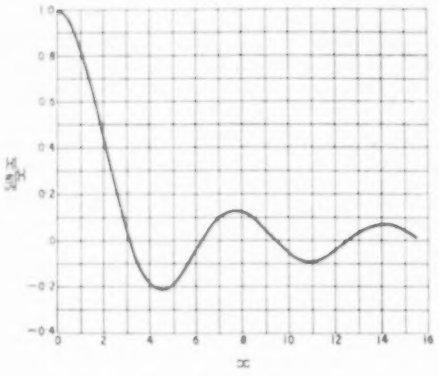


Fig. 5. Graph of the function sin x / x.

Before going on to some related topics let me recapitulate. To find the response to a very short pulse, we find the frequency and phase characteristics, compute the real part response by taking (gain) $\times$ cos (phase) at each frequency, plot this on a linear frequency scale. This real part response is then expressed as a set of trapezoidal responses and the transient response corresponding to each trapezium is calculated. Finally, we add (or subtract where necessary) all these transient responses and this is the transient response of the complete system.

When you are considering overload problems, the square-wave response is probably more convenient than the impulse response. The overshoot of the square wave gives a pretty good idea of how much safety margin must be allowed between the steady-state output and the maximum programme output. Fortunately, it is very easy to proceed from impulse response to square-wave response. In Fig. 6(a) I have drawn a fairly typical impulse response. The figures inside the curve show the number of millimetre squares in each 1-cm vertical strip, and the running total from left to right is underneath. This running total is then plotted in Fig. 6(b) and shows the square-wave response corresponding to the given impulse response. The overshoot is very small, so that even the most cautious user of an amplifier with this characteristic could operate it up to its steady tone maximum. There is nothing more to the calculation of the square-wave response: all the work is in the first stage, the determination of the impulse response.

"Ringing"

It is very useful to have some physical appreciation of the causes of the ripples in the transient response. The simplest view is obtained by noticing that our input signal contains a complete frequency spectrum extending up towards infinity. The amplifier cut-off stops all frequencies above a particular limit and therefore acts as though it produced a negative signal containing all these components with phase reversed to add to the original signal. Some of the filter text-books show what happens to a square wave passed through a high-pass filter, and this damped oscillation is the wave to be subtracted from a square wave which has passed through a low-pass circuit. The

reader who checks up on this will no doubt ask why I haven't pointed out that the filter books also show the transient response of a low-pass circuit. The reason is that I wish to emphasize the fact that the transient distortion is due to terms above the maximum transmitted frequency and that they are not in themselves audible.

Feedback amplifiers present some special and rather interesting transient characteristics. To the mathematician the reason is very simple : the phase characteristic hugs the zero line up to near the cut-off, and then rises very sharply. That's fine, but what does it mean ?

Delayed Feedback

The easy way to understand what happens in a feedback amplifier is to watch a pulse going through it. A typical amplifier, let us say, has a frequency response without feedback which is 20 db down at 20 kc/s, and we are using 20 db of feedback. The phase shift will probably be 180 degrees at about 25 kc/s. The delay through the amplifier, without feedback, is given by the shape of the phase characteristic, $d\theta/d\omega$, and the average value of this is $\pi/2\pi$.25,000 or 1/50,000 sec, or 20 μsec later. Until the pulse reaches the output the feedback cannot begin to have any effect, so that with a square-wave input the first 20 μsec of output is amplified by the full gain of the amplifier. At the end of 20 μsec the feedback starts to operate, but during this short period you may have blocked off a grid somewhere in the circuit. I do not pretend that the description here is complete : it is, however, of very great value if you are designing an amplifier with feedback round an output transformer, when the early stages are usually made with very wide band response in order to achieve stability. These conditions lead to a pulse at the output grid which may be about ten times the size of the steady-state signal. There are quite a lot of complications which can arise in particular circumstances, but I do not propose to discuss them here.

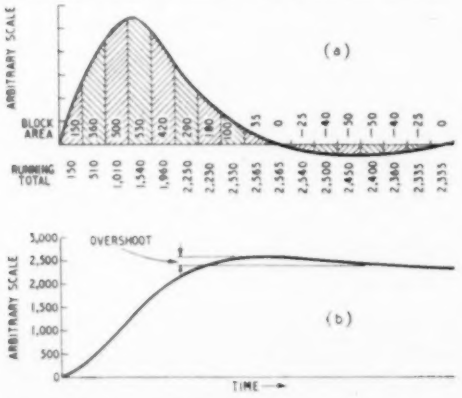
It is not suggested that in all cases you should calculate the transient response before you build an amplifier. One feature of the theoretical method, however, is that it provides a background which helps in interpreting the transient responses you can see on the oscilloscope.

Square-wave responses of amplifiers have often been published in *Wireless World*, but there is a method of studying the transient response which has not been mentioned, so far as I can remember. This is to differentiate the amplifier output and thus obtain the impulse response, at the same time making sure that the amplifier behaves well with both negative and positive swings.

The differentiating circuit is simple, a series capacitance and shunt resistance after the load and before the oscilloscope. The shunt resistance should be fairly large compared with the load, while the capacitance should be chosen to give high impedance compared with the shunt resistance at all frequencies of interest. Typical values would be 100 pF and a few thousand ohms. The advantage of this method is that it shows up the ripples on the response much more clearly : ideally the square wave when differentiated will just give a spike of very short duration ; all else is error.

To conclude, a note on the calculation of " droop " caused by a bad low-frequency response is needed. The procedure here is fairly simple : you plot the real part response in just the usual way, and then take the trapezium, or set of trapezia, which would be needed to make the response go down to zero frequency. The impulse response is then calculated for these trapezia, and the square-wave response obtained by counting squares (integration). This response is subtracted from the ideal square wave, and there is your drooping characteristic.

Fig. 6. Square-wave response is obtained by counting squares in the elements of area under the impulse response curve, and then plotting the running total. (a) Typical impulse response. (b) Corresponding square-wave response.



R.I.C. SPECIFICATIONS

THREE new component specifications and additional sections for some existing ones have just been issued by the Radio Industry Council. These specifications are prepared in conjunction with B.R.E.M.A., R.C.E.E.A. and R.E.C.M.F. and are for the time being intended for use within the industry.

Sections 1 and 2 of the new specifications are available now and these cover performance requirements and production tests. Sections 3 of each, defining types of the components covered, their ratings and sizes, will be issued later.

RIC/151 deals with dolly operated switches of the toggle type for use in d.c. and a.c. circuits not exceeding 500 V and 15 A loading and for frequencies up to 3 kc/s. RIC/154 relates to single- and multi-wafer rotary switches and concerns two types; one for use up to 100 kc/s and the other up to 100 Mc/s.

RIC/251 deals with valveholders of the kind commonly used in radio receivers and other electronic equipment. It covers two types of valveholders; those with low loss insulating material having power factors below 0.002 at 1 Mc/s and those with poorer material with power factors greater than 0.002 at 1 Mc/s. RIC/151 and 154 cost 6s each and RIC/251 5s 6d; this is inclusive of part 3 in each case, which will be supplied later.

The additional sections now available are parts 3 for RIC/111, non-insulated wire-wound resistors, and defines the standard values, tolerances, sizes and finishes; for RIC/122, variable-track composition resistors, again giving values and also switch ratings when fitted; and for RIC/133, defining values, tolerances and ratings of fixed ceramic grade 1 capacitors. These complete the three specifications concerned.

International Television Standards

IT has been pointed out that our not-infrequent references to the "C.C.I.R. 625-line" television standard might be read to imply that both the French 819-line system and our own 405 lines do not conform with C.C.I.R. recommendations. It is, of course, quite true that the C.C.I.R. (after a Study Group had inspected and assessed the systems operating in both hemispheres in 1950) advocated the adoption of 625 lines. At the VIth Plenary Meeting of the C.C.I.R. in Geneva last year it was, however, found impossible to arrive at unanimous agreement for the adoption of any one of the existing four systems; 405, 525, 625 or 819 lines. It was, therefore, decided to incorporate in the published report of the meeting* details of each of the systems for the information of administrations wishing to adopt one of them, and these are given in Table A. Each system has, *ipso facto*, the approval of the C.C.I.R., but, as one delegate remarked, to standardize four systems is not standardization.

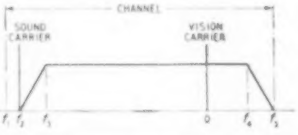
Ideal vision characteristics, based on details published by the C.C.I.R., for each of the four systems are given in Fig. 1. Details of the frame synchronizing waveforms (incidentally "field" is used throughout the C.C.I.R. documents) and, inset, the line synchronizing pulse for each of the systems are given in Fig. 2.

In certain respects there is a measure of unification. Each of the four systems conforms to the C.C.I.R. recommendation regarding line interlacing (2/1), aspect ratio (4/3), direction of scanning (L to R and top to bottom), vision modulation (amplitude), asymmetrical transmission, independence of black level on picture content, and capability of operation independent of the frequency of the power supply. Incidentally, the C.C.I.R. decided that there was no need to standardize the polarization.

* "Documents of the VIth Plenary Assembly of the C.C.I.R.," International Telecommunication Union, Geneva.

TABLE A. DETAILS OF EXISTING SYSTEMS

	405	525	625	819
Vision bandwidth (Mc/s)	3	4	5	10.4
Channel width (Mc/s)	5	6	7	14
Sound carrier relative to vision carrier (Mc/s)	3.5	+4.5	+5.5	−11.15
Sound carrier relative to edge of channel (Mc/s)	+0.25	0.25	−0.25	+0.10
Line frequency (c/s)	10,125	15,750	15,625 ± 0.1%	20,475
Frame frequency (c/s)	50	60	50	50
Picture frequency (c/s)	25	30	25	25
Sense of vision modulation	positive	negative	negative	positive
Level of black as % of peak carrier	30	75	75	25
Minimum level of carrier as % of peak carrier	0	≤15	10	≤3
Sound modulation	a.m.	f.m. 25 kc/s 75 μsec pre-emphasis	f.m. 50 kc/s 50 μsec pre-emphasis	a.m.



	405	525	625	819
f_1	−3.75	−4.75	−5.75	−11.25
f_2	−3.5	−4.5	−5.5	−11.15
f_3	−3	−4	−5	−10.4
f_4	0.75	0.75	0.75	2
f_5	1.25	1.25	1.25	2.75

Fig. 1. Transmitter characteristics for each of the four systems. Frequencies are relative to the vision carrier which the C.C.I.R. recommends should be 1.25 Mc/s from f_5. The sound carrier (f_2) should be 0.25 Mc/s from f_1.

KEY TO WAVEFORMS IN FIG. 2.

	405-line	525-line	625-line	819-line
A (peak white)	100%	15% (±2.5%)	10% min.	100%
B (black)	30% ± 3%	75% ± 2.5%	75% ± 2.5%	25% ± 2.5%
C (sync.)	0—3%	100%	100%	<3%
D (vert. sync. pulses)	4 lines	3 lines	3 lines	—
E (frame suppression period)	14 lines (1.4 msec.)	13-20 lines (1—1.6 msec.)	19-31 lines (1—1.6 msec.)	41 lines (2 msec.)
F (pre-equalizing pulse)	—	3 lines	3 lines	—
G (post-equalizing pulse)	—	3 lines	3 lines	—
H (line period μ sec.)	98.7	63.49	64	48.84
J (frame pulse duration μ sec.)	40 ± 2	27.3	—	—
K (front porch μ sec.)	1—1.5	1.27	0.64 (±0.32)	0.5
L (line pulse duration μ sec.)	8—10	5.08 ± 0.634	5.76 ± 0.64	2.5
M (back porch μ sec.)	6—9	3.81 ± 0.634	5.12	5
N (rise time μ sec.)	0.25	0.254 max.	0.256	—
N_1 (μ sec.)	>1	—	—	—
P (equ. pulse duration μ sec.)	—	2.54	2.88	—
Q (μ sec.)	—	31.74	32	—
R (μ sec.)	—	4.44 ± 0.634	5.12 ± 0.64	—

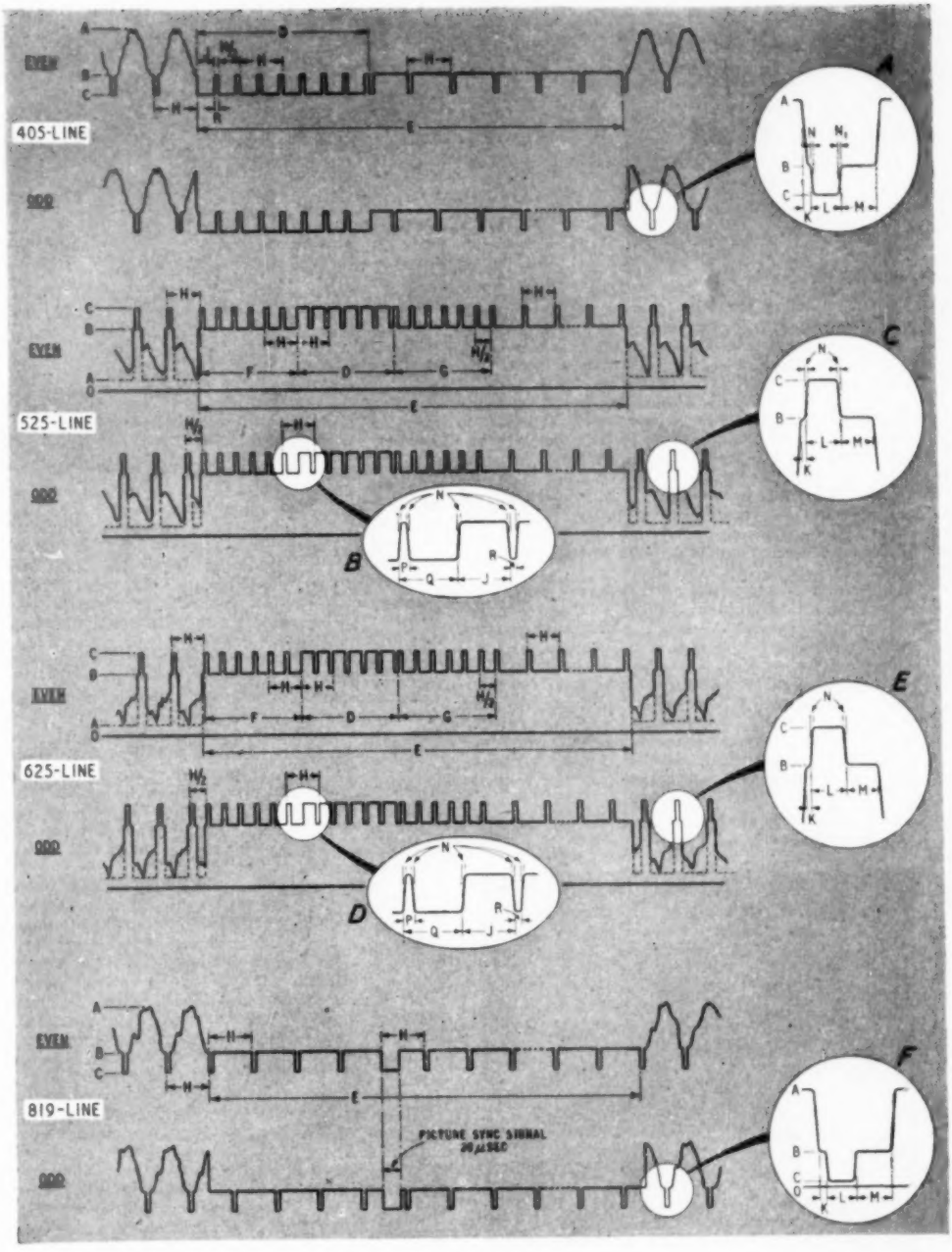


Fig. 2. Waveforms of the line and frame signals for the even and odd frames for each of the existing four television systems. Inset are enlargements showing the details of the line synchronizing pulses. The key to the lettering is given on the opposite page. The C.C.I.R. also gives a modifiation of the 625-line vertical sync signals as proposed by the Swiss delegation. In this D, F and G are 2·5 lines.

Television from Paris

Conversion from French to British Standards

The famous Eiffel Tower, from the top of which the vision signals started their journey by radio relay to London.

THE week of television programmes from Paris which British viewers saw recently was technically a major exercise in outside broadcasting—and outside broadcasting in two senses of the word. First of all, since the aim of the week was to present various aspects of the life of Paris, it was necessary to send out cameras to places all over the city rather than televise from the studios—and, in fact, only one of the seventeen programmes came from a studio. Secondly, from the point of view of the B.B.C. engineers in London it was a matter of a long-distance outside broadcast from Paris, and this with the added complication of having to convert the French high-definition 819-line pictures to our own 405-line standard.

The whole operation was a joint effort of the B.B.C. and its French counterpart, the R.T.F. (Radiodiffusion et Télévision Françaises), and the programmes were seen simultaneously by viewers in both countries.

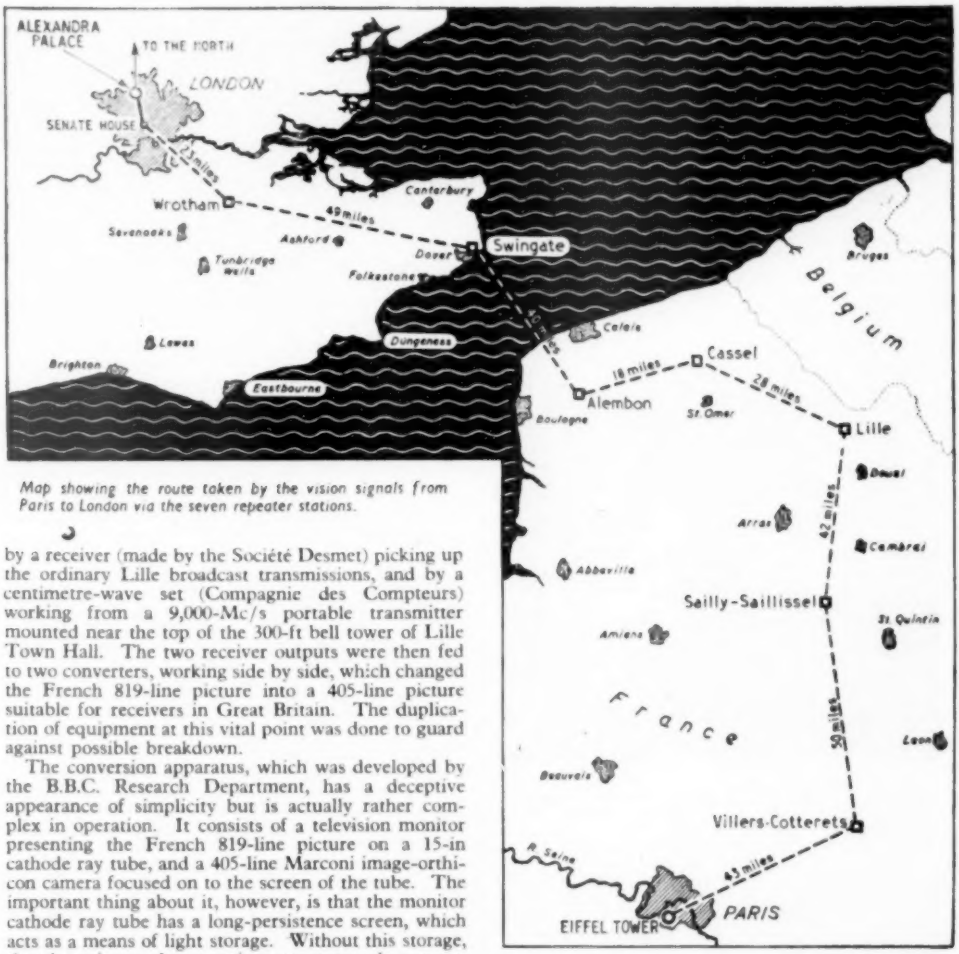
In Paris the work of televising the sixteen outside programmes was shared between four mobile camera units, each consisting of a group of cameras with an equipment for control and mixing. The first was the normal R.T.F. outside broadcasting van with two super-iconoscope cameras, and the second was a new van with three image-orthicon cameras, both of these vehicles being constructed by the French firm Radio-Industrie. The third was a mobile unit with four image-orthicon cameras, specially lent for the occasion by Pye, of Cambridge, while the fourth was a small "suitcase" equipment with two photicon cameras made by the French Thomson-Houston company. Vision signals from these four mobile units (all 819 lines, of course) were sent to a receiving point on the Eiffel Tower by centimetre-wave radio transmitters made by the Compagnie des Compteurs.

B.B.C. equipment for converting the French 819-line pictures to 405-line pictures.

In the Eiffel Tower are the two R.T.F. television transmitters which serve the Paris area (one for 819 lines at the top and another for 441 lines at the bottom), and these receive their programmes by cable from the studio centre in the rue Cognacq Jay, about half a mile away, and by radio from the outside broadcasting points as explained above. On this occasion the Tower was also the starting point of the chain of radio links, some 300 miles long, which conveyed the vision signals to London.

The first part of the journey, from Paris to Lille, was done by way of the existing French television relay which supplies programmes to the 819-line transmitter at Lille. This is an experimental system installed by the French Thomson-Houston company until a permanent one is built. It has two intermediate repeater stations at Villers-Cotterets and Sailly-Saillissel, which are unattended and controlled by time switches and have duplicate equipment throughout as a precaution against possible breakdown. In each repeater the radio equipment is mounted at the top of a 245-ft tower with two 10-ft paraboloidal aerials, one for transmitting and the other for receiving. About 5 watts of r.f. energy at 850 Mc/s is beamed from one station to the next, and the total gain of each repeater is in the region of 90 db.

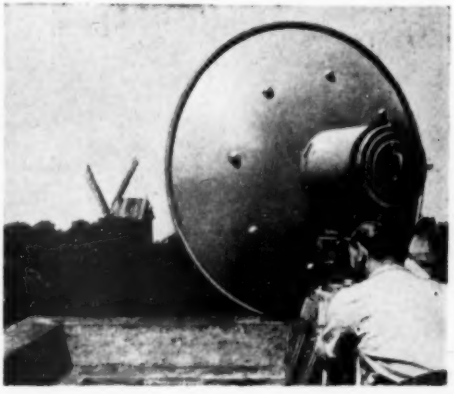
On arrival at Lille, the vision programme was radiated by the transmitter there and passed on to the first of the temporary relay stations set up by the B.B.C. This was at Cassel, a small town which, because of its position on the only hill for miles around, was used as a military headquarters in the 1914-18 war and as a wireless station in both wars. Here, on the roof of an old casino at the very top of the hill, the vision signals were received from Lille in two ways—



Map showing the route taken by the vision signals from Paris to London via the seven repeater stations.

by a receiver (made by the Société Desmet) picking up the ordinary Lille broadcast transmissions, and by a centimetre-wave set (Compagnie des Compteurs) working from a 9,000-Mc/s portable transmitter mounted near the top of the 300-ft bell tower of Lille Town Hall. The two receiver outputs were then fed to two converters, working side by side, which changed the French 819-line picture into a 405-line picture suitable for receivers in Great Britain. The duplication of equipment at this vital point was done to guard against possible breakdown.

The conversion apparatus, which was developed by the B.B.C. Research Department, has a deceptive appearance of simplicity but is actually rather complex in operation. It consists of a television monitor presenting the French 819-line picture on a 15-in cathode ray tube, and a 405-line Marconi image-orthicon camera focused on to the screen of the tube. The important thing about it, however, is that the monitor cathode ray tube has a long-persistence screen, which acts as a means of light storage. Without this storage, that is, using a short-persistence screen, the camera mosaic would behave like a simple photo-cell, quite independently of the scanning beam, and would give a fluctuating output corresponding to the intensity variations of the cathode ray tube spot. This fluctuating output would be, of course, a replica of the 819-line vision waveform and would beat with any signal obtained from the mosaic in the normal way by scanning to produce a completely meaningless waveform from the camera. By using a long-persistence screen, however, a large component of unmodulated light is introduced, and if the proportion of unmodulated light to modulated light is made sufficiently great the intensity variations of the spot are rendered negligible and have little or no effect on the camera mosaic. One might say that the long-persistence screen serves to "smooth out" the intensity variations *in time* of the



Right: Setting up a Marconi centimetre-wave transmitter on the roof of the casino at Cassel for beaming the vision signals to Alembon.

spot but leaves them recorded at positions *in space* on the screen where they can be detected in the normal way by the camera scanning system. Actually, the persistence of the screen (zinc beryllium silicate) is such that the brightness of any point in the image falls exponentially to 28 per cent of its original value during the period of one frame (20 milliseconds).

In addition to the "photo-cell effect" there is another difficulty which has to be avoided. Although the frame frequencies of the monitor and camera are nominally the same (50 c/s), in actual practice they differ slightly and, of course, the phase relationship of the two scanning systems is continually changing. Sometimes the camera beam is behind the monitor beam, giving a reduced signal output, sometimes ahead, giving an extremely low signal, and sometimes the two beams coincide, giving a maximum signal. The result in the final 405-line "converted" picture would be a fluctuation of intensity corresponding to a beat between the two frame frequencies, and this would occur to some extent even with a long-persistence monitor screen. In the B.B.C. converter, however, the effect is overcome by operating the camera pick-up tube on a part of its characteristic that introduces sufficient storage, or "memory," to smooth out the fluctuations.

A certain amount of degradation of the picture is introduced by the optical system of the converter, but this is corrected by equalizer circuits in the camera.

It is customary for the frame scan of B.B.C. cameras to be locked to the 50-c/s mains frequency of the grid system in this country to avoid "hum bars" appearing on viewers' receivers, so on this occasion it was necessary to convey the 50-c/s signal from the mains out to the cameras at Cassel by a special land line.

The vision signals having thus been converted to British standards, they were transmitted over the next link of the chain, from Cassel to Alembon, by a Marconi centimetre-wave radio link working on about 7,000 Mc/s. Similar equipments, made by E.M.I. and working on about 4,500 Mc/s, then conveyed the signals across the Channel to the R.A.F. radar towers at Swingate, near Dover, and on to the B.B.C. experimental v.h.f. station at Wrotham. This last jump was notably long (49 miles) for such high-frequency working, but was made possible by the improved type of klystron valve in the E.M.I. equipment which gives the transmitter an output power as high as 3·5 watts. Finally, the signals were transmitted from the mast at Wrotham to the top of the Senate House of London University by an S.T.C. centimetre-wave equipment, again working on about 4,500 Mc/s. After that they went underground for the first time, being sent by coaxial cable through Broadcasting House to the Alexandra Palace transmitter, from which point they were distributed by our own permanent network of cables and radio links to the transmitters at Sutton Coldfield, Holme Moss and Kirk O'Shotts.

The sound for the programmes was conveyed direct from Paris to London by land line. Over the B.B.C. part of the relay, from Cassel to London, each repeater station was equipped with a Mullard v.h.f. transmitter/receiver so that engineers along the route could communicate with each other.

Incidentally, the conversion of one television standard to another was used at another point in the system, within the French television service itself. In Paris there are, as stated earlier, two television systems, one operating on 819 lines and the other on 441 lines, and hitherto they had been transmitting separate programmes. For the Franco-British week, however, they were arranged to radiate the same programme, and this was achieved by means of a converter, similar to the one at Cassel, which enabled the 441-line viewers to see the pictures produced by the 819-line system. It was installed near the base of the Eiffel Tower and consisted of an 819-line monitor scanned by a 441-line camera, the output of which was fed to the 441-line transmitter in the usual way.

About two-thirds of the 40,000 viewers in the Paris area have 819-line receivers, while the rest are on 441 lines and a few have dual-standard sets. The 46-Mc/s low-definition vision transmitter, however, radiates on the much greater power of 30 kW (as against the 3 kW of the 185-Mc/s high-definition one), so there is a tendency for viewers well outside the city to have 441-line sets, as a matter of necessity, while those in the centre have 819-line sets.

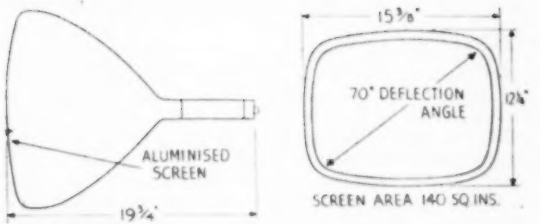
Pye 819-line image-orthicon camera televising a panoramic view of Paris from the Eiffel Tower and (below) S.T.C. centimetre-wave receiving paraboloid mounted on the roof of the Senate House, London University.

Now generally available!
Rectangular Wide-Angle BRIMAR Teletubes

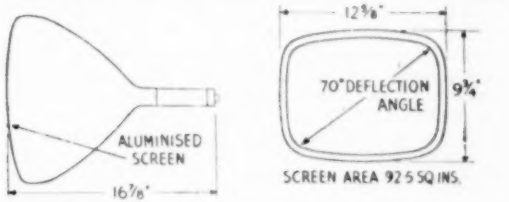
SET MAKERS in particular will be interested to know about these advanced Brimar rectangular, wide-angle Teletubes at present available in two sizes—the C 17 BM with a screen area of 140 sq. in., and the C 14 BM with an area of 92.5 sq. in. Both have aluminised screens and external conducting coatings.

Their rectangular construction permits the full screen area to be used and allows a considerable reduction in the depth and volume of cabinets.

NOTE. Because of the wide deflection angle and increased neck diameter of these tubes, ordinary scanning components cannot be employed.



C 17 BM
Heater Voltage 6.3V Heater Current 0.6A Anode Voltage 16kV nom.
Cut-off bias —70V Modulation 30V peak (for 150 μA beam current)



C 14 BM
Heater Voltage 6.3V Heater Current 0.6A Anode Voltage 12kV nom.
Cut-off bias —70V Modulation 30V peak (for 150 μA beam current)

Adequate E.H.T. and line and frame scan are provided by these valves for both the C 17 BM and the C 14 BM when operated from a 200 Volt HT rail in conjunction with high efficiency wide-angle scanning components.

VALVES for WIDE ANGLE LINE and FRAME DEFLECTION CIRCUITS

	6CD6G Line output tetrode	6U4GT Efficiency diode	12BH7* Frame osc. and output	1T2.R16 E.H.T. Rect.	R.12 E.H.T. Rect.
Heater Voltage	6.3 v.	6.3 v.	6.3 or 12.6 v.	1.4 v.	6.3 v.
Heater Current	2.5 A.	1.2 A.	0.6 or 0.3 A.	0.14 A.	0.09 A.
Peak Anode Voltage	6 kV	Peak Heater Cathode Voltage 3.85 kV	Amp. Factor 17	Peak Inverse Voltage 15 kV	17.5 kV
Peak Cathode Current	0.5 A.	Peak Inverse Voltage 3.85 kV	Impedance 5,500Ω		

* *Not yet available for retail sales*

BRIMAR BRITISH MADE **VALVES and TELETUBES**

Standard Telephones and Cables Limited FOOTSCRAY, SIDCUP, KENT

One head *can* excel at two jobs: A TURNOVER PICK-UP CARTRIDGE COMES TO STAY

The introduction of commercially produced microgroove recordings brought to the user the complication of having to use two different styli. At once the question arose as to the best way of changing over from one stylus to the other. From the layman's point of view—and the largest proportion of the gramophone playing public are laymen—the "best way" means the "simplest way." This explains the popularity of pick-ups with both styli fitted to the same cartridge and the provision of mechanical means, such as a simple swivel action, to bring one or the other stylus into use. The Acos G.P.25 has been one of the most popular cartridges of this type. Unfortunately, there have been serious technical objections to such dual stylus cartridges, and technical people as a rule have been accepting them merely as a concession to an overriding demand for simplicity.

Technical Objections

There were principally two objections, both of which were concerned with the output characteristics of such cartridges. First, it was argued, the considerable difference in the recording characteristics of the Standard and the Long Playing records required either two cartridges with two different reproducing characteristics or two separate compensating circuits. Neither is very simple or easy with a single cartridge. Secondly, it has been found that the free stylus tends to vibrate at its own resonant frequency, producing a deep trough in the overall response, thus spoiling the quality of reproduction to a noticeable extent.

The system of using two separate heads avoids all these difficulties, as must be obvious to every sound engineer. The heads can be designed each to fulfil its specific purpose and they can be provided with means for plugging in or clipping on for comparatively easy change-over. The Acos G.P.20 is a good and well-known example of such a pick-up.

Practical Advantages

Nevertheless, a pick-up which can be changed from Long Playing to Standard and vice versa is so enormously attractive for all commercial and general purpose applications, that Cosmocord just could not help making a thorough investigation into the possibility of mass-producing a dual-stylus cartridge with acceptable reproducing characteristics for both types of records.

It was established from purely theoretical considerations that, given a set of critical conditions, the solution was possible. The real difficulties arose when trying to stipulate these critical conditions in terms of practical engineering and finding means of maintaining them in large quantity production. These difficulties could have proved insurmountable had it not been for a realistic approach right from the start by Cosmocord engineers, combined with the wide scope of Cosmocord's resources, which include considerable experience in the development and manufacture of special purpose materials. Eighteen months of intensive work resulted in the introduction to the Radio Industry by Cosmocord of the Acos G.P.29 cartridge.

THE G.P.29 PICK-UP CARTRIDGE

This new Acos cartridge is designed to give the best possible reproduction of both Standard and L.P. records with the normal run of domestic radio sets under home conditions. No input correction is required apart from exceptional cases. The usual tone control on the set could provide additional adjustment to suit individual taste, but is not essential. The output of around 0.7V. at 1,000 cps. from Standard and about half that from Long Playing records is right for present-day requirements. The difference between the two output levels is no greater than variations found between recordings, and is no more noticeable in use. The response characteristics of the two sides of the dual-cartridge unit are tailored to give optimum performance in both cases. The "Standard" side gives a falling characteristic beyond 5 kc. The bass end is compensated to within around — 3 dbs at 70 cps. The result is well-balanced reproduction suggesting wide range but no or very little needle scratch. Long Playing records with their softer and smoother surface require no top cut except to compensate for pre-emphasis in recording. However, the amount of top cut already in existence in a domestic receiver more than compensates for this. So much so that to give best overall balance the long playing output of the G.P.29 cartridge had to be raised substantially above 5,000 cps.

A very important feature of this cartridge is that it will truly track both types of record at 10 grams needle pressure. This, coupled with the appreciable vertical compliance of the cantilever stylus to compensate for pinch effect, ensures long record life and freedom from distortion.

The cartridge takes two sapphire tipped cantilever styli which are held in the needle chuck by a set screw. They are easily replaceable when so required in service. The cartridge is supplied either with two side brackets or mounted in a turn-over mechanism, and is available to manufacturers only. The public are going to like the G.P.29. Insist that it is incorporated in the gramophone equipment *you* sell.

COSMOCORD LIMITED · ENFIELD · MIDDLESEX

R.F. Characteristics of Capacitors

Outline of Factors Controlling Performance

By R. DAVIDSON,* B.Sc., A.Inst.P.

THE limitations imposed on the effectiveness of a given capacitor in a circuit by the operating frequency, or frequencies, are often overlooked or ignored by users of capacitors. As a result, the circuit either tends to instability or, more usually, the capacitor is not fully effective and its function could be more efficiently performed by a capacitor of different type and, perhaps, of different value.

Two typical applications of capacitors in which these frequency limitations show themselves are in the decoupling circuits of radio frequency amplifiers and in radio and television interference suppression networks. Of these, the former will probably be the more familiar to readers. Fig. 1 shows a single stage of a typical radio frequency amplifier C_1, C_2, C_3, being the anode, screen grid and cathode decoupling capacitors respectively. In such amplifiers the d.c. supply to the anodes and screen grids of the valves represents a low impedance common to each stage of the amplifier. If radio frequency voltages from any stage are developed across this common impedance, regeneration will take place and the amplifier may tend to become unstable. It is essential, therefore, that all radio frequency currents shall be by-passed to earth from all anode and screen grid supplies and all cathodes not themselves returned directly to earth.

Referring to Fig. 1, this means that the radio frequency voltages developed across AE, BE and CE must be negligible. The decoupling capacitors C_1, C_2, C_3, must therefore have as low an impedance as possible at the radio frequency to be by-passed, and it is desirable, again from the point of view of stability, that their reactance be capacitive at this frequency. As will be seen later, owing to the inherent inductance of capacitors and the inductance of their leads, these reactances may be inductive and appreciable. For example, a typical 0.1-μF tubular paper dielectric capacitor with short leads may have an inductive reactance as high as 30 ohms at 45 Mc/s, and would be virtually useless for decoupling or interference suppression at television frequencies. Even a 0.005-μF capacitor with lead lengths as short as 2 cms is inductive at 45 Mc/s and can have an impedance in the region of 10 ohms. Being inductive, it may cause trouble when used as a decoupling capacitor, and its impedance is too high for it to be effective for television interference suppression when used across the low-impedance sources or mains supplies usually met with in this field. However, as will be seen later, a 500-pF capacitor with similar lead lengths can have an impedance as low as 1 ohm at 45 Mc/s, and is substantially non-reactive at frequencies in this region. With shorter lead lengths it will be capacitive and will still have a lower impedance at this frequency than the 0.005-μF capacitor of similar type and lead lengths. Choice of capacitor type and capacitance for by-passing purposes thus depends very much on the operating frequency. The extent of the limitations imposed by the operating frequency on the effectiveness of capacitors and the factors governing these limitations will now be examined in detail.

Every capacitor has a certain value of inherent inductance which, together with lead inductances, will form a series resonant circuit. At frequencies less than the self-resonant frequency the capacitor has a capacitive reactance and, except in the immediate region of resonance, its impedance will be almost the same as its theoretical value. At frequencies greater than the self-resonant frequency the capacitor will have an inductive reactance and its impedance will increase with frequency. This inherent inductance is, therefore, a most important property of every capacitor, since it controls the maximum frequency at which the capacitor will exhibit a capacitive reactance.

The main factors which control this inductance are as follows: (i) The dimensions of the external leads to the capacitor and the internal leads to the capacitor section. This applies to all types of capacitor. (ii) The ratio of the length of the capacitor section to its diameter (for rolled cylindrical paper and tubular ceramic dielectric capacitors). (iii) The proximity of the outer casing of the capacitor, if metal, to the capacitor section. (iv) The method of connection of the leads to the capacitor section.

Of the above (i) has the greatest influence on the total series inductance of the capacitor circuit. With an ordinary two-lead capacitor the minimum lead

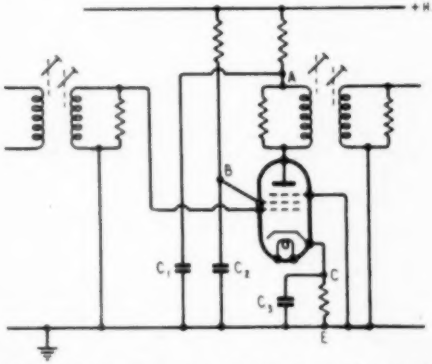


Fig. 1. Single stage of a typical r.f. amplifier showing anode, screen and cathode decoupling capacitors.

* Dubilier Condenser Co. (1925) Ltd.

lengths necessary, in practice, to make connections to the external circuit will have inductances of the same order of magnitude as that of the capacitor section itself. For example, the inductance of two centimetres of 22 s.w.g. tinned copper wire, often used for the leads of small capacitors, approximates to that of the capacitor section so that an extra two centimetres of lead on either side of the capacitor will reduce its resonant frequency by a third. Thus increasing the lead lengths of a 0.1-μF tubular paper capacitor from 1 cm to 3 cms lowers its resonant frequency from 3.3 Mc/s to 2.2 Mc/s; a similar increase on a 500-pF paper dielectric capacitor reduces its resonant frequency from about 54 Mc/s to 36 Mc/s.

One method of reducing the lead inductances of a capacitor is to take the leads of the external circuit into and out of the respective poles of the capacitor via two terminal connections as shown in Fig. 2. These two terminals make a common connection to the capacitor foils so that the only series inductance remaining in the capacitor circuit is that of the section itself. Apart from the limitation imposed by the inductance of the section, it is practically impossible to eliminate the inductive and capacitive coupling between the incoming lead AB and the outgoing lead BC so that, with the increasing frequency, the capacitor is itself by-passed to an increasing extent. Using the two-terminal method of connection the resonant frequency of a 0.1-μF capacitor with an isolated or non-metal casing can be raised to a maximum of about 6 Mc/s.

The inductance of a capacitor section is controlled by its physical dimensions. For a rolled paper capacitor with extended foil construction the effective inductance at radio frequencies approximates to that of a hollow tube of the outer dimensions of the capacitor section. This inductance L is given by:—

$$L\ (\mu H) = 2l\left\{\log_e \frac{2l}{r} - 1\right\} \times 10^{-3}$$

where l is the length of the section and r is the radius of the section, both in centimetres.

For a given capacitance, therefore, a short section with a large number of turns on the winding will have a lower inductance than a long section with fewer turns and the resonant frequency of the short section will be correspondingly higher than that of the long section. Using the above formula for both the section and the wire connecting leads for a given tubular capacitor the total series inductance, and hence the resonant frequency of the capacitor and its leads, can be predicted very closely. The effect of section dimensions on inductance for various overall sizes of 0.1-μF rolled paper dielectric capacitor plate is shown in the Table together with the self-resonant frequency of the section.

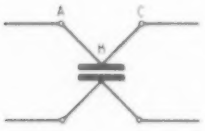
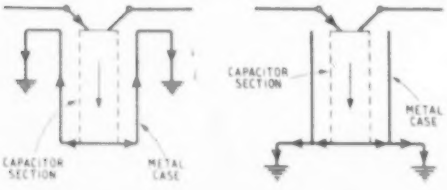


Fig. 2. Capacitor having two terminal connections to each plate in order to reduce lead inductances.

Fig. 3. Capacitor with a metal case forming one plate and showing r.f. current paths with two different methods of earthing.



TABLE

Dimensions of Section		Inductance of Section	Self-resonant frequency of Section
Cms.		μH	Mc/s
Length	Diam.		
2.9	1.3	6.7×10^{-3}	6.1
3.2	1.3	8.2×10^{-3}	5.3
3.2	1.0	9.4×10^{-3}	5.2
4.8	1.8	12.9×10^{-3}	4.4
4.1	1.0	15.1×10^{-3}	4.1

The inductance of tubular silvered ceramic dielectric capacitors can be similarly derived using in the aforementioned formula the outer dimensions of the ceramic tube.

Silvered ceramic disc capacitors with high permittivity dielectrics are now being used increasingly for by-passing. Such capacitors have inherently low self-inductances due to the shape and small physical dimensions of their silvered areas (the inductance being of the order of half that of the equivalent paper dielectric capacitor). These capacitors are, therefore, suitable for high frequency by-passing in situations where their relatively high power factor and high temperature coefficient of capacitance are unimportant. Similar discs with low permittivity ceramic dielectric of the type often used as h. f. couplings are in the very low capacitance range and have self-resonant frequencies considerably higher than their normal operating frequencies. They may, therefore, be considered capacitive for all practical purposes providing their external leads are kept short.

In practice, the inductance of the capacitor section may be modified, under certain circumstances, by the type of container in which it is housed. With capacitors housed in metal containers which are isolated from the poles of the capacitor, the metal case has a negligible effect on the inductance of the section. Where the metal case forms one pole of the capacitor (which is usually earthed), the casing forms part of the radio frequency current path through the capacitor. The effective inductance of the section will thus be influenced by the proximity of this casing to the section and will depend on the position at which the external connection is made to the case. Assuming the case is earthed, Fig. 3 shows the two extreme positions for making this external connection. In Fig. 3 (a), the radio frequency current passes through the capacitor section and back via the case in the opposite direction. There is a certain degree of coupling between the case and the section, depending on their mutual proximity, so that the effective inductance of the section is reduced below its free space value. This effect is greatest with a close-fitting case.

When the earth connection is made as in Fig. 3 (b),

this reduction of inductance is far less marked and the resonant frequency is correspondingly lower. For example, a 0.1-μF capacitor with close-fitting case and two-terminal type of input resonates at 5.1 Mc/s when earthed as in Fig. 3 (a), and at about 4 Mc/s when earthed as in Fig. 3 (b). Hence, for radio frequency by-passing, it is advantageous to use capacitors with the case forming one pole and with the earth connection made at the same end as the input connection.

The method of connection of the leads to each pole of the capacitor may influence the total inductance of the capacitor. A large number of tubular paper dielectric capacitors nowadays have a so-called non-inductive winding with one set of foils projecting at each end of the capacitor. These projecting foils are all soldered together and the connecting lead usually terminated by a flat spiral soldered to the end of the section. This provides an excellent electrical connection to the section and parallels together the foils of each plate, thus limiting the current flow along the winding to a minimum and reducing the inductance of the section and its connections.

Another method of connection to the capacitor section is via a projecting metal lug inserted during the winding and making intimate contact with the plate. This method is slightly more inductive than the projecting foil method, but, providing the lug is inserted at the correct point of the winding, the inductive effect of current flow along the winding is negligible. The resistance of the foils may, however, be appreciable at very high frequencies, and this will result in the power factor of capacitors made with lug connections being higher at these frequencies than those made with projecting foils.

It is sometimes necessary, because of limited space, to use two or more sections wound on the same mandrel to provide separate capacitors within the same housing. Connections can then with convenience only be made to the sections by means of lugs inserted in the windings and, as the sections are usually wound in series, it is not possible to arrange the points of connections such that all sections are non-inductive. Multi-section capacitors wound in this way will thus have at least one section which will have more inductance than its extended foil equivalent and will hence have a lower resonant frequency.

There is one type of wound capacitor which approaches the ideal capacitor over a range of frequencies up to at least 150 Mc/s and which makes use of the methods described above for reducing series inductance to a minimum. This is the "bushing" or "feed-through" capacitor in which the current carrying conductor passes through the centre of the capacitor. One set of foils is connected by the extended foil technique directly to the central conductor whilst the other set of foils is similarly connected to the outer metal casing. The capacitor is employed as a bushing to carry the central conductor through an earthed plate to which the capacitor is fixed and to which all radio frequency currents carried on the central conductor are to be by-passed. By this method of construction all lead lengths to the capacitor section are eliminated and the incoming lead carrying the radio-frequency currents is completely screened from the outgoing lead by the earthed plate.

Detailed examination of the transfer impedance-frequency characteristics of these capacitors is beyond the scope of this article, but the characteristics are so unique as to require a brief description. Feed-through capacitors behave at high frequencies as

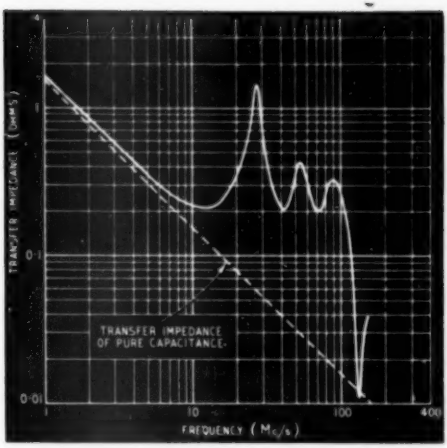
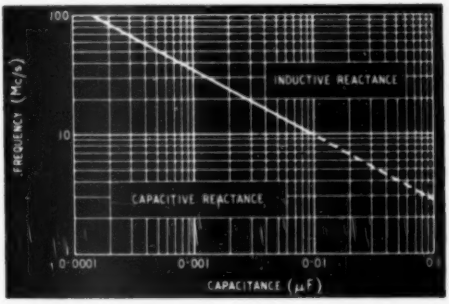


Fig. 4. Transfer-impedance characteristic of a typical 0.1-μF paper dielectric "bushing" capacitor.

Fig. 5. Self-resonant frequency-capacitance curve for metallized paper capacitors with lead lengths of 1 cm.



heavily attenuated open-ended sections of transmission lines of very low characteristic impedance. From details of the construction of these capacitors, it is possible to determine the length, attenuation constant and transfer impedance of the equivalent transmission line, and hence to predict where the resonant peaks and troughs will occur in the transfer impedance-frequency characteristic of the capacitor. The transfer impedance of these capacitors, which is the parameter controlling the effectiveness of the capacitor for radio frequency suppression work, is low for frequencies up to at least 150 Mc/s. A typical transfer impedance-frequency characteristic for a 0.1-μF paper dielectric "bushing" capacitor of 50 A through current rating is given in Fig. 4.

Having examined the factors which control the inductance of a capacitor, the series resonant property can be dealt with in more detail. To illustrate the order of frequency at which series resonance occurs for various values of capacitance Fig. 5 shows the series resonant frequency against capacitance for the miniature metallized paper dielectric type of capacitor having leads one centimetre long at either end. By virtue of the method of construction of this type of capacitor, the overall physical dimensions of the sec-

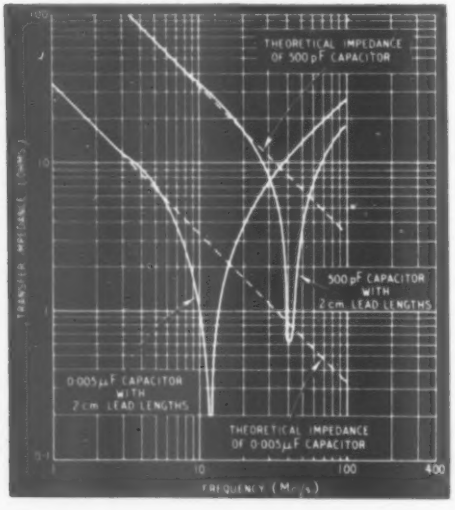
tions vary only slightly over the capacitance range 100 pF to 0.01 μF, so that the graph in Fig. 5 is almost a straight line. The extrapolated portion of the graph will assist in estimating self-resonant frequencies for greater values of capacitance.

Apart from giving an indication of the upper frequency limit of usefulness of a given capacitor, the self-resonant frequency is usually avoided, but recently this property has been put to good use for certain applications. For a 0.1-μF tubular paper capacitor, with extended foil connections, the total series resistance of the capacitor is low and hence the "Q" of the series resonance is high, giving a narrow resonance curve about 500 kc/s wide only at 6 db down. Though capacitors of this size have an extremely low impedance at series resonance the resonance curve is too narrow to be of much practical use. However, with very much smaller capacitors, for example, of the metallized paper dielectric type, the foil losses at high frequencies are not negligible and the self-resonance "dip" is very much wider due to the inherently lower "Q" of the resonant circuit. For such capacitors the impedance may be less than theoretical over a frequency band as wide as 20 Mc/s within the resonance "dip."

Over this frequency band the capacitor will provide better by-passing than any larger capacitance of similar type and equal lead lengths. This is illustrated in Fig. 6 which shows the transfer impedance-frequency characteristic, through resonance, of a 500-pF metallized paper capacitor and a 0.005-μF capacitor of similar type and equal lead length and diameter. It will be seen that, from 30 Mc/s upwards, the smaller capacitor has a lower impedance than the larger capacitor and that from about 25 Mc/s to 50 Mc/s the impedance of the 500-pF capacitor is less than its theoretical value.

Very good use can be made of the series self-resonant frequency property of small capacitors within the television band 40-70 Mc/s where capacitances of the order of 500 pF, using a centimetre or so of connecting lead, provide excellent by-passing over a large portion of the band. By using such low value capacitors at series self-resonance in conjunction with small inductors at parallel self-resonance (also with wide frequency band coverage) most effective filters can be made covering the whole television band. Such filters are unique in that they provide higher attenuation at these frequencies than can be obtained by any combination of larger values of nominal capacitance and inductance. These filters occupy very little space and have recently been successfully used for television interference suppression of electrical appliances. In this connection specially designed television frequency chokes as small as ½in long by ¼in diameter are available for use with the well-known types of small metallized paper, paper or mica dielectric capacitors.

Fig. 6. Transfer-impedance-frequency characteristics through self resonance for paper dielectric capacitors of 500 pF and 0.005 μF.


THEORETICAL IMPEDANCE OF 500 pF CAPACITOR
500 pF CAPACITOR WITH 2 cm. LEAD LENGTHS
0·005 μF CAPACITOR WITH 2 cm. LEAD LENGTHS
THEORETICAL IMPEDANCE OF 0·005 μF CAPACITOR
TRANSFER IMPEDANCE (OHMS)
FREQUENCY (Mc/s)
10
100
400

NEW B.B.C. CHARTER

THE plethora of words, both spoken and printed, which preceded the granting of the new Charter* to the B.B.C., makes it difficult to dissociate fact from fiction. By and large there are but few major changes in the terms under which it will operate for the next ten years—for that was the period, starting from July 1st, for which the Charter was granted. Of course, the B.B.C. cannot fulfil the function outlined in the Charter without a licence from the Postmaster-General, and it was this Licence and Agreement†—and the Government's whole policy on broadcastings§—which were so heatedly debated in Parliament.

Technically the main change in the licence is that it stipulates specifically that any additional stations needed to improve the coverage of the Home Services will employ v.h.f.—the actual phrase is "emit waves at more than 30 Mc/s".

The most significant, and certainly the most hotly debated, section of the White Paper was that relating to the introduction of competitive television. In the Charter, too, the phrase "non-exclusive licences" appears.

The proposed introduction of a Committee of Appointment for the selection of Governors was withdrawn by the Government, so that the Board of Governors—now to be nine instead of seven—will continue to be appointed by the Crown. Three of those appointed will in future be "National Governors" for Scotland, Wales and Northern Ireland. In order to give the greatest possible measure of autonomy to these countries, National Councils are to be set up within the framework of the B.B.C.

It may be worth recording that whereas under the old licence the Corporation paid the P.M.G. £10 p.a. for each transmitter, the new licence stipulates an all-embracing annual fee of £500.

Although irrelevant to either the Charter or Licence, it is noteworthy that the Government has stated that it is to grant a fifteen-year licence to the broadcast relay exchanges and "power to the P.M.G. to take over compulsorily then, or thereafter, by two years' notice."

* Cmd. 8605. † Cmd. 8579. § Cmd. 8550.

Simple Line-Scan Circuit

Transformerless System with H.T. Boost

By W. T. COCKING, M.I.E.E.

THE general principles of efficiency line-scan circuits were discussed in a recent article[1] in some detail. Attention was directed chiefly to the most efficient mode of operation in which the two valves—the driving pentode and the efficiency diode—function alternately during the scan, each for about one-half of the scan period. This is, by no means, the only possible mode of operation, however, and it was pointed out that it is usually necessary to sacrifice efficiency somewhat by permitting the operative periods of the valves to overlap in order to avoid unduly critical circuit adjustments.

Some considerable attention was paid to a circuit embodying a directly-fed deflector coil which has the great practical merit of not requiring a line-scan transformer. In spite of the fact that h.t. boost is not possible with it, it was shown that it is quite practicable to scan a 53 tube operating at 10 kV with an h.t. line of the order of 250 V only.

The main practical drawback to the circuit is the difficulty of obtaining an e.h.t. supply from it. This difficulty has now been removed by a development referred to by Starks-Field[2]. An extra inductance is included in the circuit which serves two purposes. It increases the peak voltage on fly-back sufficiently to enable e.h.t. to be obtained. If this were all it would not help, for it would necessitate an inconvenient increase in the h.t. line, but it also permits h.t. boost to be obtained. The two factors enable an efficient circuit without a line-scan transformer to be devised.

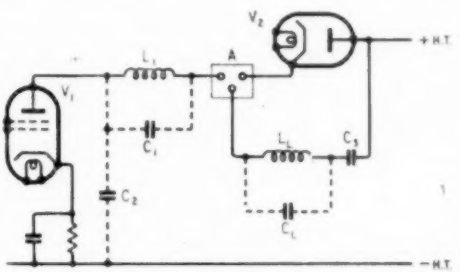


Fig. 1. Basic form of transformerless scanning circuit. The box A is the linearity-controlling device.

The new circuit is shown in its basic form in Fig. 1 and without the e.h.t. system ; the box A represents the linearity control and need not be considered at present, there is a conductive path between all three of its terminals. The capacitances C_1 and C_L represent the self-capacitances of L_1 and L_L while C_2 is mainly the output capacitance of V_1, but may, in practice, be augmented by external capacitance. C_3 is the capacitance across which the boost voltage appears and is assumed to be very large ; in practice it is usually over 0.5 μF. The inductance L_1 is the deflector coil.

Towards the end of the scan the diode V_2 is cut off and the current of V_1 flows through L_1 and L_L. At the end of the scan it has the peak value i_p and V_1 is then cut off. If L_1 were not present, the current in L_L would undergo one-half cycle of damped oscillation at a frequency determined by L_L and the total stray capacitance. V_2 would then conduct to inhibit further oscillation and to control the decay of current in L_L. At this instant the current would have the value $e^{-\pi/2Q}$ where Q is the quality factor of the tuned circuit formed by the deflector coil and the stray capacitance.

The factor $e^{-\pi/2Q}$ has been previously designated by the letter x. It is the fractional current overshoot and usually has a magnitude of around 0.8. Because the overshoot is less than unity the mean diode current is less than the mean pentode current if the deflector-coil current is linear. If h.t. boost is to be obtained the two currents must be equal. Equality is usually achieved with the aid of a transformer, but it can also be obtained if the overshoot can be made 100%.

At the start of fly-back the stored energy in L_1 is $\frac{1}{2}L_1i_p^2$. At the end of fly-back, L_1 being absent, it is $\frac{1}{2}L_1i_p^2x^2$ and the circuit has lost energy $\frac{1}{2}L_1i_p^2(1-x^2)$. If in some way this quantity of energy can be added to the circuit during the fly-back it will just counter-balance its loss and the current at the end of fly-back will be i_p. There will be 100% overshoot.

The inductance L_1, in conjunction with the capacitances, does just this. In spite of the simplicity of the circuit the precise mechanism is complex and exact analysis is very difficult. The circuit is, in fact, a pair of top-end capacitance-coupled resonant circuits ; one circuit is L_1C_1 and the other is L_LC_L and they are coupled by C_2. Each has its own Q factor, L/C ratio and resonance frequency. It is well-known[3] that with such coupled circuits in free oscillation the energy oscillates backwards and forwards between the two so that the current in one grows at the expense of the other and then, after a maximum, the reverse process occurs and the current in the one falls off while that in the other grows. The waveform of the current has a resemblance to that of a modulated wave.

In this case we are only interested in the conditions during the first half-cycle of oscillations in L_L, for

[1] "Efficiency Line-Scan Circuits," by W. T. Cocking. *Wireless World*, August, September and October 1951, pp. 302, 347 and 425.

[2] "Reactive Time Bases," by A. B. Starks-Field, B.Sc., *J.Brit. Instn Radio Engrs.* : 1951 Convention Paper.

[3] "Principles of Radio Communication," by J. H. Morecroft, 3rd Ed, pp. 308-329. (John Wiley).

after that V_2 comes into play to prevent further oscillation in L_1. Any energy left in L_1C_1 then decays as a normal damped oscillation in that circuit alone. A few things about the circuit are easily seen. Since L_1 must transfer energy $\frac{1}{2}L_1i_p^2(1-x^2)$ to L_L in one-half cycle of oscillation of the latter it must initially have more stored energy than this. The peak current in the two inductances is the same and so the initial energy in L_1 is $\frac{1}{2}L_1i_p^2$. If L_1 had no losses and if all its energy were transferred to L_L, this initial energy would have to be equal to the energy required by L_L and this would give $L_1 = L_L(1-x^2)$. This is the minimum possible value for L_1 and leads to a value around 0.3 L_L.

However, L_1 has its own losses. If these are of the same order as those of L_L, the initial stored energy, and hence the value of L_1, must be doubled to make up for them. It is obviously unreasonable to expect that L_1 would be left with no stored energy at the end of the fly-back period, or even if it is, that there should also be no energy left in C_1 or C_2. If we assume arbitrarily that the energy left in the circuit is one-half of the initial energy, so that of the initial energy roughly one-quarter is transferred to L_L and one-quarter is lost, then L_1 must be 1.2 L_L. This is not in violent disagreement with practice but in the writer's experience it is better to make L_1 about double L_L.

If the capacitance C_1 is too large, the energy in L_1 cannot be removed from it quickly enough to enable sufficient to be transferred to L_L. In practice, it seems advantageous for C_1 to be as small as possible. The major factor affecting the energy transfer is C_2. If it is too small, the energy transference is also too small and the scan is non-linear (picture compressed on the left). An excess of capacitance is less harmful; in fact, above a certain value C_2 has very little effect on the scanning waveform although it does have an effect on the total amplitude and also on the peak voltage across L_1.

Inductive Back E.M.F.

During the scan of period τ_1 there is a back e.m.f. L_1I_L/τ_1 across L_1, where I_L is the peak-to-peak current in L_L. If the diode V_2 is cut off at the end of the scan and if the overshoot during the fly-back is made 100% by the transference of energy from L_1, then the current I_L is just twice the peak anode current of V_1. It is necessary once every cycle to bring the current in L_1 from zero to i_p; while the current is changing, a back e.m.f. is produced across L_1. In order to minimize the h.t. supply voltage it is necessary to make this back e.m.f. as small as possible. It is a minimum when the change of current is linear and when it occupies as long a time as possible. The current of V_1 should, therefore, rise linearly during the full scan period τ_1 and it can then be expressed as i_pt/τ_1. The back e.m.f. across L_1 is then L_1i_p/τ_1. The mean anode current of V_1 is $\frac{i_p}{2}\cdot\frac{\tau_1}{\tau}$ where τ is the full period of one cycle including the fly-back.

It would, of course, be quite possible to operate with V_1 and V_2 conductive alternately for half the scan period. The back e.m.f. across L_1 would then be $2L_1i_p/\tau_1$ (twice as great) and the mean anode current $\frac{i_p}{4}\cdot\frac{\tau_1}{\tau}$ (one-half). The power involved would be the same. Practical limitations are usually on voltage and peak current rather than on mean current, so that it is usually better to choose the mode of operation in which V_1 is conductive throughout the scan. This in turn requires V_2 to be conductive throughout the scan and to carry a current $i_p(t/\tau_1 - 1)$. As will appear later, this condition is one which leads more easily to the attainment of linearity than the other.

The three currents,—i_v the anode current of V_1, i_d the current of V_2, and i_L the deflector-coil current—are shown in Fig. 2. This diagram also shows the algebraic expressions for the current during the scan in the convenient form of d.c. components plus time-varying parts having no d.c. component. The latter are indicated by the symbol $A_t(=t/\tau_1 - \frac{1}{2})$.

Linearity Circuit

In the previous article[1] it was stated that the linearity device A of Fig. 1 usually has a form such as that of Fig. 3. This resonant arrangement is necessary when the two valves are not conducting together, for the circuit must be energized by V_1 and yet control V_2 when V_1 is non-conducting. It must, therefore, store energy. While the circuit operates successfully, it is critical in adjustment and there are too many variables for it to be easy to determine the proper values; thus, there are the total inductance, the position of the tapping point, the value of the capacitance and the damping. Practically, only the inductance is variable as a user control, but all have to be initially determined, usually empirically. A major difficulty is to know how much latitude to allow for variations of other components.

When both valves are conductive for the whole scan period a different corrector can be used which is not only much less critical but lends itself to more precise design. The circuit element is the same as in Fig. 3 but with the capacitance replaced by resistance.

In Fig. 4 is shown the equivalent circuit in which L_L and R_L represent the deflector coil and R_d represents the diode V_2 when conducting; this representation is approximate only, since the diode resistance is not a constant. R represents the resistance element of the

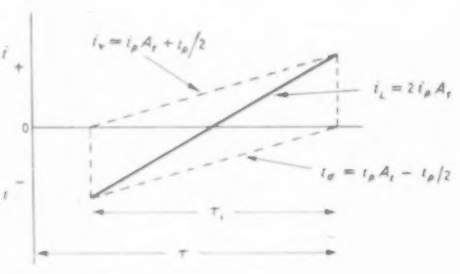


Fig. 2. The currents during the scan of the driving valve i_v and the diode i_d are shown dotted and their combination, which is the current i_L in the deflector coil, by the solid line.

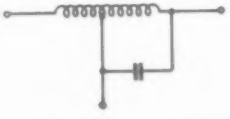


Fig. 3. Form of linearity device (A of Fig. 1) which is commonly used in efficiency scanning circuits.

linearity control. On the left the waveform diagrams show the voltages across each component, as the voltage of its upper terminal with respect to its lower. The top one shows the constant boost voltage V_B across C_B, the next the inductive back e.m.f. across L_L and the bottom the saw-tooth voltage across R_L. The total voltage E is the sum of the three components and is

$$E = V_B - 2L_L i_p \tau_1 - 2 i_p R_L A_t.$$

This voltage must also exist across R_d and R on the right-hand side. Here the diode current i_d flows through both resistances, and the transformer of the linearity circuit feeds extra current i to R only. The voltage drop across R_d is shown to its right and the saw-tooth is in the wrong sense to that required. The large saw-tooth required must be produced across R and be the sum of two components, one due to i_d, again in the wrong sense, and the other an over-riding one due to i. We can write for the right-hand side

$$E = i_p R_d A_t - \frac{i_p R_d}{2} + i_p R A_t - i R A_t.$$

It is to be noticed that because of the transformer winding across R there can be no d.c. component in the current i nor in the voltage across R. This equation must equal the previous one and so the terms in them which are time-dependent and those which are not must be independently equal. Therefore the boost voltage is

$$V_B = \frac{2L_L i_p}{\tau_1} - \frac{i_p R_d}{2}$$

and the linearity current is

$$i = i_p \left[1 + \frac{2R_L + R_d}{R} \right].$$

If this current is obtained by connecting the transformer primary as shown so that the valve current flows in the primary, then the ratio of primary/secondary turns, n, must be equal to i/i_s, so

$$n = 1 + \frac{2R_L + R_d}{R}.$$

There must be a voltage developed across the primary and this is n times the voltage across R. This voltage is $i_p R A_t n(n-1)$. The total voltage across the whole circuit is thus $E + i_p R A_t n(n-1)$

$$= \frac{i_p R_d}{2} + i_p R A_t n(n-1) + 2 i_p R_L A_t.$$

At the end of the scan, when $A_t = \frac{1}{2}$, this is a maximum and the voltage is then

$$E_T = \frac{i_p}{2} (2R_L + R_d)(1 + n).$$

Obviously n should be as small as possible, but it must exceed unity ; R should thus be large.

At this stage it is profitable to consider an example. It is found that a certain deflector coil of 30 mH inductance and 55 Ω resistance requires a peak-to-peak current of 0.3 A ; a diode resistance R_d of 150 ohms may be assumed. Then $i_p = 0.15$ A and, taking τ_1 as 90 μsec, the inductive back e.m.f. across L_L is $0.3 \times 30/90 = 100$ V. The mean drop across the diode is $0.15 \times 150/2 = 11.25$ V and so the boost voltage is $V_B = 100 - 11.25 = 88.75$ V.

The total voltage E_T is $0.075 \times 260 (1 + n) = 19.5(1 + n)$. If $n = 1$, which means $R = \infty$ and is impracticable, $E_T = 39$ V. If $n = 2$, which is an eminently practicable value, $E_T = 58.5$ V. We now must add on the voltage across L_1 of Fig. 1. If $L_1 = 2L_L$ it is 60 mH. The current is 0.15 A and so the inductive back e.m.f. is 100 V and the total voltage becomes 159 V. To this must be added the resistive drop in L_1, the minimum anode-cathode voltage of V_1 and the drop across its cathode-bias resistor. All these will total around 100 V, so that an h.t. supply of around 260 V is called for. The anode current is $75 \times 90/99 = 68$ mA and the power input 17 W.

It is a fact that practical figures agree very closely with these. Using a metal rectifier for the diode, the boost voltage obtained is nearer 70 V than 89 V ; the metal rectifier is, in fact, more accurately represented by a battery and a resistance in series than by a simple resistance. Then the valve used, an EL38, requires 275 V for the screen in order to give 150-mA peak anode current, so an h.t. line of 280 V is suitable in practice, making the input power about 19 W. With a voltage-tripler rectifier system 10 kV at 100 μA can easily be obtained from the anode of V_1. The peak voltage on the deflector coil is slightly under 1.5 kV and that across L_1 rather under 3 kV.

It is desirable that R should not be large, for the inductance required in the transformer is proportional to it. Ideally, this transformer should handle without distortion a saw-tooth current wave when its secondary is loaded by R. If the inductance of that portion of the winding in shunt with R (the secondary) is L, then a saw-tooth wave will droop from its proper value at the end of the scan by $\tau_1 R/L$. If we allow 10% droop, $L = 10\tau_1 R = 0.0009$ R

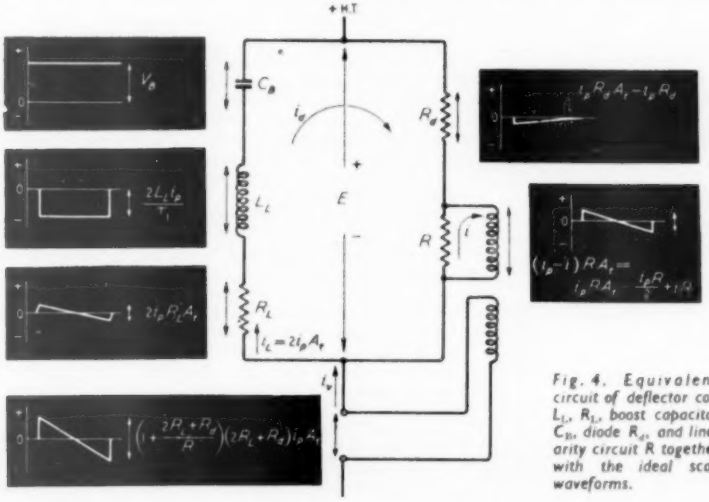


Fig. 4. Equivalent circuit of deflector coil L_L, R_L, boost capacitor C_B, diode R_d, and linearity circuit R together with the ideal scan waveforms.

henrys. The total inductance of the whole winding is $(1 + n)^2$ times this. It is easy to show that the total inductance is a minimum when $R = R_L + R_d/2$ and $n = 3$. However, this makes the voltage rather large and it is sometimes better to use a larger value of R. If $n = 1.5$, so that $R = 2(2R_L + R_d)$, the total inductance becomes $0.0056R = 0.0112\ (2R_L + R_d)$. In our example this is $0.0112 \times 260 = 2.9$ H. This must be with the direct current of the stage through the full winding.

However, experiment shows such a large inductance to be quite unnecessary and a value of under 1 H is ample, while 0.25 H only seems sufficient. The reason for this is that the circuit is a correcting one and is correcting a circuit which alone does not depart from linearity by more than 10—15%. Quite a large error in the correcting wave may still lead to a final error which is quite small. Then some correction is possible by adjusting R to a value different from the theoretical one. Then, again, the diode cannot accurately be represented by a resistance.

The theory is approximate only for simplicity, and experiment, always the final arbiter, shows that the inductance can be without harm $\frac{1}{2}$ to $\frac{1}{10}$ of the figure given by the above expression.

The complete circuit diagram of a stage which the writer has used experimentally with very satisfactory results is shown in Fig. 5. The pentode V_1 is driven with a saw-tooth voltage which can be derived from any conventional saw-tooth voltage generator. It is advisable to have a waveform with a negative-going pulse on the fly-back and this is usually easily obtainable by including a resistor of some 2-10 kΩ in series with the charging capacitor. The pulse cuts V_1 off rapidly on fly-back and so increases the e.h.t. voltage.

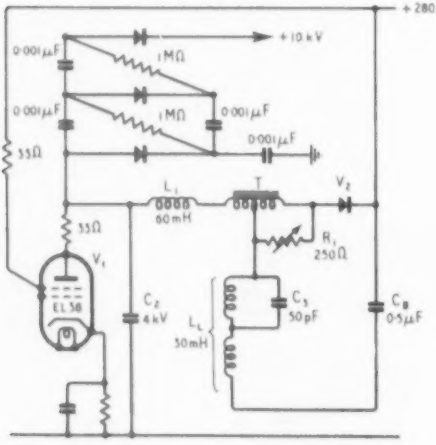


Fig. 5. Complete circuit of experimental line-scan stage.

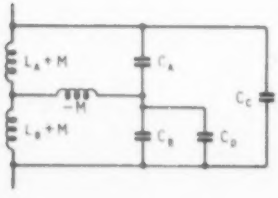


Fig. 6. Equivalent circuit of a deflector coil.

L_1 can be any low-capacitance coil wound to withstand some 3 kV across it and up to some 4.5 kV to earth, while T can consist of 1,000 turns of No. 34 enamelled wire tapped at 250 turns from the V_2 end on a $\frac{1}{2}$-in stack of No. 74 laminations. The smaller part of the winding is in series with V_2. No special insulation is needed in the winding but the winding as a whole must be insulated to withstand at least 1.5 kV between itself and the core. Alternatively the whole transformer, including the core, can be insulated from the chassis. This is, in practice, the most convenient because the transformer needs acoustic insulation also and it is easy to provide both together by placing the transformer inside a block of sponge rubber under pressure. In any case, however, R_1 must as a whole be well insulated from the chassis.

Deflector-Coil Ringing

The capacitance C_2 across one-half of the deflector coil is necessary to prevent ringing in the deflector-coil assembly itself. The equivalent circuit of the assembly is shown in Fig. 6. The two inductances L_A and L_B together form the deflector coil and are equal, or nearly so, and have mutual inductance M between them. The capacitances C_A and C_B represent the self-capacitances of L_A and L_B and are roughly equal. C_C and C_D are the capacitances to earth of L_A and L_B.

In this circuit there are several possible modes of resonance and the troublesome one is when L_A and C_A together are inductive and come into series resonance with a capacitive L_B and $C_B + C_D$. The circuit rings in this mode to produce a series of vertical light and dark stripes on the picture towards the left-hand side.

The effect is not peculiar to this circuit but occurs with any lightly-damped deflector coil. A simple remedy is to increase the capacitance across the non-earthy coil of the pair so that the parallel resonance frequencies of the two circuits, considered independently, are the same. The series mode then disappears. The capacitance for complete avoidance of visible ringing is quite critical; however, a fixed capacitance will usually remove it sufficiently for it not to be detectable save on a blank raster. This is usually sufficient and in view of the voltage (750 V) it is not always convenient to use an adjustable capacitor.

The capacitance C_2 in Fig. 5 can be used as a width control if it is made variable. Its mechanical form is a little troublesome since it must withstand at least 4.5 kV. An air-dielectric capacitor becomes very large physically and for practical convenience a solid dielectric is desirable. However, it is difficult to make a solid-dielectric variable capacitor which does not have, in some degree, an air gap between the plates and the solid dielectric. If there is such a gap a discharge occurs across it. In the writer's experience, therefore, it is better to make C_2 fixed and to control picture width in some other way, such as, by varying the saw-tooth drive to V_1.

This capacitance C_2 can then be mainly the valve capacitance, but it does need some 5-10 pF extra. It is best obtained with an air dielectric using about $\frac{1}{16}$-in spacing of the plates. Provided that it is not too small, it can be fixed and the amount of overshoot can be controlled by varying the rate of cut off of V_1. This can be done by including a 10-kΩ variable resistor in series with the charging capacitor of the saw-tooth voltage generator (not shown in Fig. 5).

This circuit has proved very satisfactory in use and gives ample output to scan a 53° tube operating at

10 kV with a deflector-coil assembly having an LI^2 figure of 1.4 mH-A^2 (this is for an MW 22-7 tube at 5 kV, see "Deflector-Coil Characteristics," *Wireless World*, March, April and May 1950). It has also proved to be non-critical in adjustment and consistent in performance.

Under typical conditions with an EL38 valve and a 280-V h.t. line the mean anode current was 73 mA and the boost voltage was 60 V while the e.h.t. supply was 9.8 kV at 100 μA.

The deflector coil must be designed to withstand up to 1.5 kV on fly-back. So far, the writer has had no difficulty from this and no coil has yet broken down from this cause.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

"Restrictive Practices"

IN the leading article of the June *Wireless World* you suggest that the General Post Office, by licensing the television-to-schools transmissions, has shown signs of a more liberal attitude towards non-broadcast applications of television. Would that I could agree with your argument in support of that view!

As I see it, you underestimate the monopolistic powers granted under the Wireless Telegraphy Act to the Postmaster-General. His only real obligation is to keep within the framework of the International Convention to which this country is a party. According to my reading of the Radio Regulations annexed to the 1947 Convention, the P.M.G. did not need to "take his courage in both hands" before licensing the schools transmitter, which could come into the category of either a "Special Service" or "Experimental" station. Licences for cinema television transmitters, or, for that matter, for any likely non-broadcast uses of television, would readily fall into the same categories.

London, S.W.1. C. R. HUGHES.

V.H.F. Broadcasting

HAVING also recently returned from a visit to the U.S.A., I can in general confirm the comments of J. R. Brinkley in your July issue. To the average American "f.m." and "v.h.f." broadcasting are, of course, synonymous. So far as we in England are concerned, however, there are two aspects: the pros and cons of (1) v.h.f. broadcasting and (2) of the system of modulation, and we should not tend to confuse the issues. I propose to air my views on (1) only.

In a country where there is established a generally satisfactory medium-wave broadcast service, v.h.f. broadcasting only offers to the man-in-the-street the advantage of high fidelity (but only at considerably increased cost). We all know how few can be persuaded to take an interest in high fidelity—give them a simple tone control on an ordinary broadcast receiver, and nine out of ten will wipe off what high frequency response the receiver has! They prefer the "woomf."

So far as minority areas are concerned; that is, those not adequately covered by the existing medium-wave service, v.h.f. can be looked upon as a valuable supplement in providing interference-free channels. In my opinion, only in these areas would limited B.B.C. expenditure on new stations be warranted.

There is no doubt that in a few years television will be of prime interest and will hold a greater public than sound broadcasting, which will gradually take a back seat.

This fact should also not be overlooked—it is happening in U.S.A. already—and therefore, large-scale B.B.C. expenditure should be on television development.

If it came to a choice, those areas poorly served by the present sound broadcasting service would, I think, rather have a good television service than merely v.h.f. broadcasting.

The case would be different if we were just setting up a sound broadcast service; I would then be all for v.h.f., but it would now seem rather late in the day to be thinking about it.

Liverpool. D. W. HEIGHTMAN.

Thorn Needles

S. KELLY'S article in your June issue provides welcome data on the performance of thorn needles. May I suggest, however, that insufficient damping of the pickup itself may have been responsible for the excessively pronounced peaks in thr high-frequency response?

I have made similar tests using a well-known commercial lightweight pickup specifically designed for use with thorns; normally this pickup has no tendency to excessive resonances within the limits of Decca test record K1804, regardless of needle length. When in a particularly undamped state, however, due to the magnet having been momentarily removed from the polepieces, resonances of up to 10 db in amplitude have been plotted between 6 and 9 kc/s, depending upon stylus length and thickness.

While agreeing with Mr. Kelly about the disadvantages of thorns, I hope that he does not seriously challenge their one great advantage, namely their kindness to valuable discs. It is this alone that induces me, and, I believe, a great many others, to adhere to them in spite of the extra trouble involved. It is conceded, however, that there is much room for improvement in the durability of the material used in their manufacture.

Stevenage, Herts. BERNARD DRIVER.

Too Many "Recording Characteristics"?

IT is generally assumed that three different characteristics are currently used for 78-r.p.m. domestic gramophone recordings: (a) the E.M.I. (English Columbia, H.M.V. and Parlophone records) which has a level treble frequency response; (b) the English Decca *ffrr*, which pre-emphasizes the treble in the order of 3 db per octave as from 3,000 c/s; and (c) the American N.B.A. characteristic, which pre-

emphasizes the treble at approximately 5 db per octave as from about 1,000 c/s.

Three different characteristics for 78-r.p.m. records —especially as there is now yet a fourth for 33⅓-r.p.m. long-playing records—is bad enough. It means that even to approach the ideal in reproduction, manufacturers need to provide their amplifiers with, in addition to a level response, two different compensations for 78-r.p.m. records alone.

But unfortunately that is not the end of the story. From bitter experience I am led to believe that certain American concerns (e.g., Capitol and many of the smaller companies whose records are also available here) are employing various characteristics which differ from any of those I have mentioned.

In fact, the whole position as regards recording characteristics is becoming chaotic; leaving amplifier makers at a complete loss to know how best to cope with the situation.

The solution to the problem would seem to be for all the recording companies to get together and agree on one single characteristic, or, if they cannot so agree, to use at the most two characteristics—the level treble and one pre-emphasized treble—and state the characteristic employed on the record labels.

The only way to get such a policy adopted would appear to be by calling public attention to the present miserable state of affairs.

Incidentally, pre-emphasis seems to be a mixed blessing anyway. Admitted that in the case of the familiar shellac disc it helps to attain a better signal/noise ratio. But at the same time it tends to magnify the effects of harmonic distortion, and surely a better way of reducing surface noise would be to use a level treble response and press on a more suitable stock (e.g., Vinylite), slightly more costly though this would be.

London, N.16. RUTH JACKSON.

Greenland Expedition

YOUR readers may be interested to know that the British North Greenland Expedition has been allocated the amateur radio call-sign of G3AAT/OX.

The station which will use c.w. and telephony in the 3.5, 7, 14, 21, 28 and 144 Mc/s bands, will be operated from either one of two fixed stations, one in the centre of the ice cap and the other adjacent to Britannia Lake. In addition it is possible that one of the weasel teams may use an Army 19 set.

The Signals Officer is Capt. J. S. Agar, Royal Signals, aided by C.R.E. H. Dean, R.N., and P.O. Tel. K. Taylor, R.N. The licencee of the call-sign is Instructor Lieutenant-Commander R. Brett-Knowles, R.N., who is also the assistant seismologist and navigator of the seismic weasel team.

We very much regret that it is entirely impossible at the present time to give any details of operating times, as these will depend on local conditions, such as power and operator availability. The Expedition is to be away for two years, however, and it should be possible for interested amateurs to contact us at some time during this period. Owing to absence of any mail facilities it is impossible to send QSL cards while the Expedition is in Greenland, but it is hoped that cards will be sent after the Expedition returns in 1954. Any cards for the Expedition should be addressed to BNGE, Queen Anne Mansions, London, S.W.1.

It may be recalled that G3AAT, when holding the only British Virgin Islands call-sign of KV4AAT, organized amateur communication during the riots in Grenada, B.W.I., in 1951 and also handled the communications from one of H.M.S. *Devonshire's* (Cadet Training Cruiser) long-distance cutter sailing cruises —Operation Bligh—from Barbados to St. Lucia.

M.V. *Tottan*, At Sea. R. A. HAMILTON, Chief Scientist, BNGE.

"*Valve Voltmeter Without Calibration Drift*"

SINCE the publication of my letter under this heading in your April issue (p. 146) my attention has been drawn to another commercially produced instrument whose circuit diagram closely resembles my Fig. 4 in your January issue: the Model 23 pH Meter by Electronic Instruments, Ltd. Although the principle of operation and the results obtained differ considerably, the main framework of both circuits is a pair of balanced two-stage, negative feedback, direct-coupled amplifiers. I understand that a circuit of this type has been used by Electronic Instruments, Ltd., since as long ago as 1945, but as it had not been published my search did not find it. Although I developed my circuit quite independently, I made no claims for originality, being only too well aware of the risks of so doing! But it would be interesting to know whether anybody can, in fact, claim a prior arrangement combining the following properties:

(1) Input conductance less than 10 $^{-9}$ mho.

(2) Output resistance less than 5 ohms.

(3) Output voltage equal to input voltage within a fraction of 1 per cent, for any meter resistance from 300 ohms to infinity and up to 3 mA meter current.

(4) No significant change in calibration or zero setting on varying mains voltage 10 per cent or output valve characteristics 100 per cent, as described in the article.

Bromley, Kent. M. G. SCROGGIE.

"*Re-designed Government Hearing Aid*"

THIS article in your May issue has been read with interest.

As co-author of the article in *The Post Office Electrical Engineers' Journal*, January, 1952, may I draw your attention to Table 2 of that article and the figures of 0.57 mA and 2.5 mA for anode current consumption quoted in your article? The figures quoted are those for the *insert* aid with a 45-V h.t. battery and the *external* aid and conflict with actual improvements made, which in fact, for the insert aid, are 0.35 as against 0.40 mA.

You will see from the table that while it has been possible to effect improvements in the filament consumption for both external and insert type aids, in the case of anode current, improvement is effected only as regards the insert aid.

You may be interested to know that we ultimately hope to reduce the filament current to 25 mA and possibly 20 mA and in the case of the insert aid to reduce the present h.t. consumption of 0.35 mA with a 30-V battery to something like 0.22 mA with 18 V.

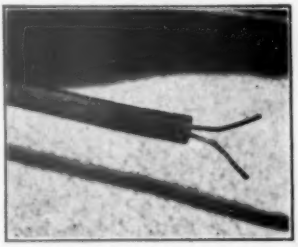
Appreciable improvement in the anode current of the external aid is also expected to be made.

London, N.W.2. C. J. CAMERON.

THE "BELLING-LEE" PAGE

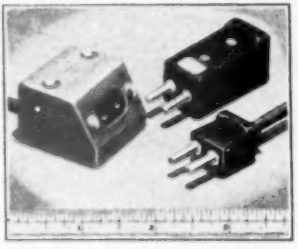
Providing technical information, service and advice in relation to our products and the suppression of electrical interference

An Economical System of T.V. Aerial Installations



Section of "Belling-Lee" twin feeder L.336.

In these difficult times when everything seems to be more expensive than is necessary, it is surely worthwhile to give consideration to a system of installing television aerials which shows a saving of over a pound per installation. This can be achieved by using "Belling-Lee" L.336 twin feeder at 7½d. per yard, instead of L.600 co-axial feeder at 1/7d., about 1/- per yard saving on cable alone. As the average installation requires 20 yards of feeder, this means a saving of a clear pound. The terminating box L.735 with its plug L.734/P for co-axial feeder costs 7/3d. against 4/4d. for a terminating box L.739 and plug



Twin feeder Outlet Box L.739 with plug L.733/P and attenuator L.741 series.

L.733/P for twin feeder, thus saving approximately another 3/-, making about 23/- in round figures.

Readers will ask "What about cases where the set maker specifies co-axial?" We say with confidence that, with the exception of fringe area reception, the twin feeder will give results indistinguishable from co-axial. All we are suggesting is that the balanced-to-unbalanced condition is transposed from the aerial end to the receiver end of the feeder.

It is appreciated by all that a balanced system is more likely to be free of interference than an unbalanced one, but this only holds good where a high proportion of the interference is picked up in the feeder as distinct from the aerial. We emphasise that a balanced feeder cannot overcome interference picked up on the aerial. Also we should like to make it clear that a twin feeder is not balanced unless it

"Balun" transformer.

terminates in a balanced load. In the very few cases where twin feeder is unsatisfactory with a receiver designed for co-axial feeder, and where there is ample signal, the insertion of an unbalanced-to-balanced transformer, known as the "Balun" L.684, will correct the condition. Incidentally the twin feeder will then be balanced. A "Balun" has an insertion loss of 3-db but this is not much when you consider the number of people who find it necessary to fit attenuators. Let us be fair, the cost of the "Balun" is 17/6d. which makes the cost of the aerial installation comparable with, but still below, that of the one using co-axial feeder and its appropriate plugs and sockets.

Help Wanted

Whilst at the British Industries Fair, Birmingham, a visitor commented on the high quality of our aerials. On being asked whether or not he had any difficulties, the visitor said he had a "ghost," but he knew how to deal with that. Naturally we were interested, how? "Oh, I just sweep the chimney and it goes." Our visitor was then lost in the crowd and we were left wondering, hard. We don't know to this day if our leg had been pulled. The ordinary viewer, using an ordinary receiver, would be unlikely to complain of a reflection from an object less than 1/4 mile distant. Did the soot lined chimney act as a director or reflector and so alter the polar diagram? Even if there was something in it, surely a swept chimney is still a carbon lined tube. Has any reader any sensible explanation? We say sensible, because it's easy to be facetious about such a matter.

Wenvoe

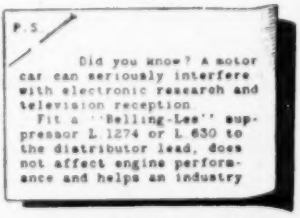
It is hoped that the Wenvoe transmitter will be on the air shortly after this is being read, and we envy the new viewers the first thrills of good television in their homes. There will be teething troubles at the transmitter, and at the viewers end as well.

With the exception of those fortunate folk "close in," the first selected site for any domestic aerial may not prove to be the best available, and it is worthwhile going to some trouble to get it right. We have made many references to Wenvoe in these pages, and to those who have mislaid useful copies, we will send reprints of each page bearing a mention of the new station. Remember, we are here to help, so do please write to us if you feel we can help you.

Installation Tips

Some time ago, we ran a series of advertisements in a trade paper giving hints and tips to radio dealers and installation engineers to help them carry out normal domestic television aerial installations. These have been reprinted, and a set will be sent to anybody who feels disposed to put up his own T.V. aerial. They would be of greater interest to radio dealers than to lay readers, as the prime essential is long ladders, and the ability to climb them safely.

Unsuppressed Motor Vehicle Ignition


P.S.
Did you know? A motor car can seriously interfere with electronic research and television reception.
Fit a "Belling-Lee" suppressor L.1274 or L.630 to the distributor lead, does not affect engine performance and helps an industry

Written 30th June, 1952.

BELLING & LEE LTD

CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND

MARCONI communication systems

serve mankind

The jungle is no longer the barrier which for so many centuries hampered the progress of communications. Guglielmo Marconi's invention of wireless overcame this obstacle just as it overcame the ocean and the desert. The Company which he founded is still exploring, in the same exacting way, new ideas and techniques for bringing communications more fully into the service of mankind.

SURVEYED

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INSTALLED

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD · CHELMSFORD · ESSEX

WORLD OF WIRELESS

National Training Scheme for Technicians • Earls Court Show • Large-screen Television • B.B.C. Appointments

Technicians' Training

WITH a view to increasing the number of technicians in the industry, the R.I. Council has introduced a national scheme of training which, in addition to being beneficial to the industry in general, may also qualify trainees for deferment of military service. It has, therefore, been necessary to define a radio technician and it has been given in these terms: "a person who carries out in a responsible manner approved techniques which are either common knowledge amongst those who are technically expert in his branch of industry or specially prescribed by professional radio engineers. These techniques are not those of the craftsman, though they may involve manual skill; in many cases they include the skilled use of delicate and complicated instruments and may also require the intelligent and accurate use of approved methods of calculation. They involve practical experience of some limited branch of radio engineering combined with the ability to complete the details of a project using well-established practice." He must have received a technical education up to a standard at least, and preferably beyond, that of the ordinary National Certificate in Electrical Engineering.

Trainees must register with the R.I.C. at 16 and will be given progressive training (until 21) through workshops (not on repetition work) followed by a period in test departments and/or laboratories. They must also be released for a day a week for training in a recognized course at an educational centre.

Television Interference

INTERFERENCE on the sound (41.5 Mc/s) and vision (45.0 Mc/s) channels of the London television station, which was widely experienced in the southern and central parts of the country during the last few days of June, was mainly caused by a station thought to be Italian on 45.6 Mc/s, Stockholm on 41.615 Mc/s and by the Paris 441-line television service on 42 and 46 Mc/s.

The ionospheric measurements made at the D.S.I.R. station at Slough on 24th June show that Sporadic E, capable of reflecting frequencies of the order of 9 Mc/s at vertical incidence, was prevalent for several consecutive hours.

This would appear to account for the interference from Stockholm and Italy, for Sporadic E with highest reflected frequency of the order of 9 or 10 Mc/s at vertical incidence would be capable of propagating the Swedish and Italian signals over the distances between the transmitting stations and this country. The interference from Paris—which was mainly experienced along the south coast, but was also heard as far north as Newcastle—cannot, however, be accounted for in this way. Since, however, it has previously occurred along the south coast during periods of settled summer weather it is evidently due to meteorological conditions, propagation being by reflection or refraction from "layers" of air in the troposphere.

The Radio Show

SINCE the ballot was held for the allocation of stands at the National Radio Exhibition (Earls Court, 26th August-6th September) a number of additional applications for space have been made so that exhibitors now total 94.

26th August (11 a.m. to 6 p.m) is to be a private view day when admission will be by special invitation from the R.I.C., by Press ticket, dealers' season ticket or by paying 5s at the door, instead of the 2s 6d admission on subsequent days.

In our next issue we shall again include an illustrated, tabulated guide to the main exhibits at the show.

Amateur Licence Changes

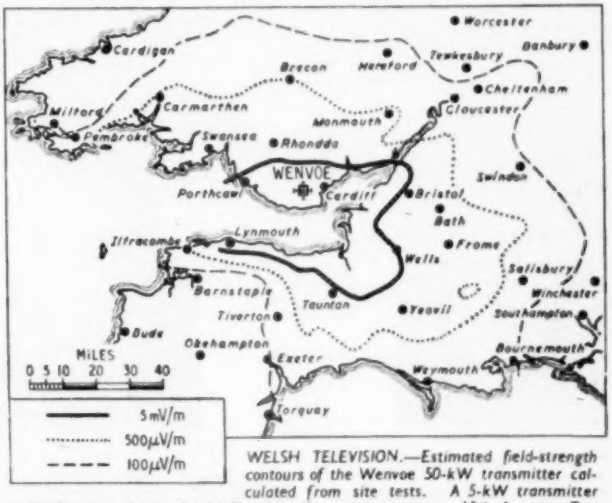
THE Post Office has decided to amend the licences under which amateurs are permitted to operate their stations at alternative addresses or under portable conditions.

"/A" and "/P" licences will continue to be available at a charge of 10s per annum, but the holder is now permitted to operate his station occasionally at an alternative address, or his portable station within 5 miles of any notified geographical location, for a period of 48 hours, provided that in both cases the Post Office Engineering Department has been notified in advance by registered letter or telegram of the location at which he intends to work. The use of a portable station on certain inland waters and lakes is also now permitted.

In addition, a new licence is now available at a charge of 10s which will permit an amateur to operate for a period of up to one month at a temporary address. This is designed to cater for amateurs who desire to operate their stations during annual holidays.

Cinema Television

LARGE-SCREEN television, using a screen 21ft by 16ft, was recently shown as part of each even-



WELSH TELEVISION.—Estimated field-strength contours of the Wenvoe 50-kW transmitter calculated from site tests. A 5-kW transmitter will, however, be used initially when the service opens on 15th August. Test transmissions are now being conducted each weekday from 11-12 and 3-4.

ing's programme during the first week's screening of "The Importance of Being Earnest" at the Odeon, Leicester Square, London. Using a closed circuit, members of the cast and mannequins wearing the costumes used in the film were interviewed and televised from an improvised studio beneath the auditorium.

Although the television picture was not as brilliant as the best film reproduction, the definition was excellent during close-ups and the general effect very pleasing.

A 625-line system is employed and the projection unit, which is remotely controlled from the normal film projection room, is located on the balcony where it is now permanently installed.

The screen, which is concave in the horizontal direction, was erected 8ft in front of the normal cinema screen in order to reduce the throw to within the limits of the optical system—52ft.

B.B.C. Engineering Appointments

WITH the retirement of Sir Noel Ashbridge from the position of B.B.C. Director of Technical Services, which he has held since 1947, Harold Bishop, who has been with the B.B.C. since 1923, is appointed to the post. He succeeded Sir Noel as chief engineer in 1943. Prior to joining the Corporation, Mr. Bishop was with Marconi's and worked on the original 2LO transmitter at Marconi House, London.

The new chief engineer is R. T. B. Wynn who, too, joined the Corporation from the Marconi Co. in 1926 as head of the technical correspondence department. He became assistant chief engineer in 1943 and deputy chief engineer in 1950.

F. C. McLean, who for the past year has been acting assistant chief engineer because of the illness of H. L. Kirke (asst. c.e.), is appointed deputy chief engineer. He joined the B.B.C. in 1936 from Standard Telephones & Cables.

reading during the 1951/52 session, four of the awards not confined to specific sections of the Institution have been given for papers on radio and allied subjects. The recipients and the title of the paper for which they received the award are :—

Duddell Premium (£20) to Drs. R. N. Bracewell, K. G. Budden, T. W. Straker, K. Weekes and J. A. Ratcliffe ("The Ionospheric Propagation of Low- and Very-Low-Frequency Radio Waves over Distances less than 1,000 km"); Ambrose Fleming (£10) to T. Kilvington, F. J. M. Laver and H. Stanesby ("The London-Birmingham Television Cable System"); Fahie (£10) to J. Bell, J. A. B. Davidson and E. T. A. Phillips ("Some Recent Developments in Phototelegraphy and Facsimile Transmission"); Heaviside (£10) to P. M. Woodward and I. L. Davies ("Information Theory and Inverse Probability in Telecommunication"); Webber (£10) to R. H. J. Cary ("A Survey of External and Suppressed Aircraft Aerials for Use in the High-Frequency Band" and "The Slot Aerial and its Application to Aircraft"); Oversea (£10) to G. Fuchs ("Reflections in a Co-axial Cable due to Impedance Irregularities"); Extra Premiums (£10) to Dr. A. T. Starr and T. H. Walker ("Micro-Wave Radio Links"); H. Grayson, T. S. McLeod, R. A. G. Dunkley and G. Dawson ("Circuit Technique in Frequency-Modulated Microwave Links"); G. King, L. Lewin, J. Lipinski and J. B. Setchfield ("Microwave Technique for Communication Links"); Dr. G. H. Metson, Dr. S. Wagener, M. F. Holmes and M. R. Child ("The Life of Oxide Cathodes in Modern Receiving Valves"); A. R. Boothroyd ("Design of Electric Wave Filters with the Aid of the Electrolytic Tank"); and Extra Premiums (£5) to Dr. E. C. Cherry ("A History of the Theory of Information"); W. J. Bray ("The Travelling-Wave Valve as a Microwave Phase Modulator and Frequency-Shifter"); and G. Millington ("The Effect of the Earth's Magnetic Field on Short-Wave Communication by the Ionosphere").

PERSONALITIES

Dr. C. J. Milner, M.A., F.Inst.P., who has been head of the physics section of the research laboratory of British Thomson-Houston Co., Rugby, since 1945, has been appointed to the Chair of Applied Physics at the New South Wales University of Technology, Sydney, Australia. Dr. Milner, who joined B.T.H. in 1936, was closely associated with the development of the klystron and magnetron. He is a Ph.D.

(*Left*) *H. BISHOP, C.B.E., B.Sc.*

(*Right*) *R. T. B. WYNN, C.B.E., M.A.*

I.E.E. Premiums

IN addition to the ten Radio Section Premiums awarded by the I.E.E. for papers read or accepted for

Dr. R. Jessel, B.Sc., F.Inst.P., A.M.I.E.E., the new chief of the Engineering Division of Electronic Tubes, Ltd. (the E.M.I. subsidiary), joined the Gramophone Co. in 1933 and in 1940 transferred to the company's c.r.t. department. For the past seven years he has not been in the radio or electronic industries.

E. C. Cherry, M.Sc.(Eng.), A.M.I.E.E., who was on the G.E.C. Research Staff from 1936-45, and after lecturing for two years at the Manchester College of Technology joined the staff of Imperial College of Science, London, has had the degree of D.Sc.(Eng.) conferred on him by the University of London. Dr. Cherry was appointed in 1949 to the City & Guilds Readership in Telecommunications endowed by Standard Telephones & Cables to provide post-graduate teaching and research in this field.

F. C. McLEAN, M.B.E., B.Sc.
(See "*B.B.C. Appointments*").

J. P. Broadbent has been appointed engineer-in-charge of the Wenvoe television station which is to be brought into service on 15th August. Joining the B.B.C. in 1931, he was at the Moorside Edge transmitter until 1935, when he went to Droitwich. During the past year or so he has been at the Midland and Northern television stations. At Holme-Moss he was assistant e.-in-c.

Richards W. Cotton, who during the war was Controller of Signals (Communications) at the Ministry of Aircraft Production, has been appointed director of the Electronics Division and chairman of the Electronics Production Board of the American Defence Production Administration. He will be on leave of absence from the Philco Corp. where he is assistant to the president. A native of Massachusetts, he lived in this country from 1934-46 and was at one time chairman of British Rola. He is a director of Philco (Overseas), Ltd., London.

R. Davidson, author of "R.F. Characteristics of Capacitors" in this issue, graduated from University College, Southampton, with B.Sc. in physics in 1941. Served for five years in the Technical Signals Branch of the Royal Air Force, four of which were spent on the radar and signals planning staff of H.Q. Air Command S.E. Asia. In 1946 he joined Dubilier Condenser Co. as a senior development engineer, and for the past two years has been engaged mainly on research into radio and television interference suppression and on the development of components for use in this field.

H. F. Humphreys, who was at one time engineer-in-chief of the Droitwich transmitter and is at present on loan from the B.B.C. to the Hellenic Broadcasting Institute as technical adviser, has been appointed head of the De-

velopment Co-ordination Service of the Institute. The immediate development plans for broadcasting in Greece include a 150-kW m.w. transmitter at Athens, a 50-kW station at Corfu and four 5-kW stations.

G. A. Jackson has been appointed manager of the Spare Parts Division of E.M.I. Sales & Service. He joined the Marconiphone service section in 1923. During the war he was concerned with the servicing of electronic gear for the Services.

K. A. Russell, B.Sc., A.M.I.E.E., chief engineer of British Relay Wireless, Ltd., and its associated companies, has been elected president of the Society of Relay Engineers.

OBITUARY

Louis Pacent, president of the Pacent Engineering Corp. of New York, which he formed in 1933, died on 6th April at the age of 58. An amateur of the early 1900s, he was a prime mover in the original transatlantic amateur radio tests of 1921 organized by *Wireless World* and the American Radio Relay League. As we recorded last year, he was awarded the Marconi Memorial Medal of Achievement by the U.S. Veteran Wireless Operators' Association for his pioneer work in radio communication.

IN BRIEF

Royal Patronage.—Her Majesty the Queen has graciously granted her Patronage to the British Institution of Radio Engineers (of which King George VI became Patron in 1946) and the Electrical Industries Benevolent Association.

Birthday Honours.—In addition to those mentioned in the last issue as having been honoured by Her Majesty, Col. A. H. Read, director of Overseas Telecommunications, G.P.O., who was formerly G.P.O. Inspector of Wireless Telegraphy, became a C.B., and among the new Officers of the Order of the British Empire (O.B.E.) were T. H. Gill, senior radio engineer, No. 90 Group, R.A.F., Farnborough, and E. Grundy, manager of the Ferranti works at Moston, Lancs.

Receiving Licences.—There were over a million and a half television licences in force in the U.K. at the end of May when the total number of receiving licences (both sound and vision) was 12,691,000. The month's increase in television licences was about 36,000, bringing the total to 1,523,000.

Standardization of communications among member nations of the North Atlantic Treaty Organization was the main subject for discussion when representatives from seven other countries recently met the British Joint Communication Board in London. During the four-day visit the group of communication officers, including representatives from the U.S.A., France, Holland, Belgium, Norway, Greece and Italy, inspected a number of radio and cable installations. Rees Mace Marine, Ltd., took the visitors on a tour of the Port of London in their launch, *Radio Dolphin*.

Professional Recording.—A new topographical list of members of the Association of Professional Recording Studios, of which the Earl of Harewood is president, has been received from the general secretary, M. K. Howells, whose address is 14, Wynchgate, Harrow Weald, Middlesex.

The Telekinema on the South Bank was re-equipped with 625-line projection television gear by Cinema-Television for the recent International Dental Congress. By its use dentists were able to demonstrate to large gatherings of delegates their latest techniques.

U.R.S.I.—The tenth general assembly of the International Scientific Radio Union, of which Sir Edward Appleton is president, will be held in Sydney, Australia, from 11th to 23rd August. This will be followed by a three-day meeting in Canberra of the Joint Commission on the Ionosphere.

Electronics Symposium.—The Scientific Instrument Manufacturers' Association is holding its fourth exhibition and symposium of papers at the Examination Hall, Queen Square, London, W.C.1, from 2nd to 5th September. Details of the programme, which includes papers on the use and development of electronic equipment for measuring, control and research, are obtainable from S.I.M.A., 20, Queen Anne Street, London, W.1, from whom tickets of admission may also be secured.

Marconi's have presented a "Seamew" radiotelephone transmitter-receiver to the *Centurion*, which is touring British ports to publicize the work of the Society for the Propagation of the Gospel in celebration of the 250th anniversary of the voyage of the original *Centurion* carrying the first missionary to go overseas for the society.

FROM ABROAD

German Exhibition.—The radio and television exhibition planned to be held in Dusseldorf from 22nd to 31st August, has been postponed until next year—27th February to 8th March.

French Television.—It is announced by Télévision Françaises that it will be adopting the C.B.S. frame-sequential system when colour is introduced for French viewers. Requiring a bandwidth of 8-10 Mc/s, it will readily be accommodated in the 14-Mc/s band used for the 819-line system. It is also planned to build six new transmitters at Strasbourg, Lyons, Marseilles, Bordeaux, Toulouse and probably Rennes.

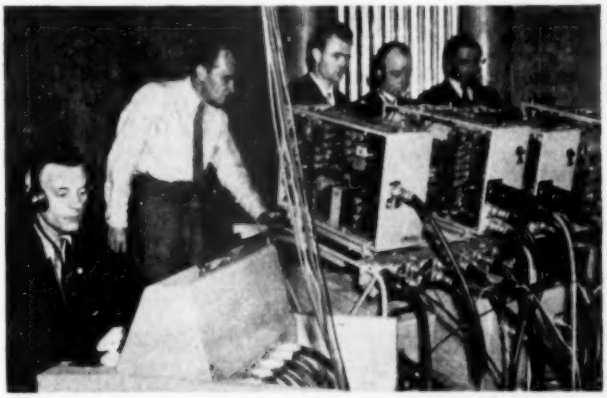
India's Radio and Electronics Exhibition, originally planned by the Radio & Electronics Society to be held in Bombay in February, and subsequently postponed until November, has now been postponed indefinitely.

Canadian Television.—Test transmissions of fixed patterns started from Canada's first television station atop Mount Royal, Montreal, early in June on American Channel 2 (54-60 Mc/s). Initially a temporary 70ft mast was used but will be replaced by a 290ft structure.

Venezuelan Television Service will be provided by British equipment operating on 625 lines. Marconi's are supplying a 5-kW vision transmitter, 3-kW sound transmitter, aerial system and studio installation, together with a mobile outside broadcasting unit with radio relay links.

Hawaii's first television station, which will operate on Channel 4 (66-72 Mc/s), is to be erected in Honolulu by the Radio Corporation of America for a publishing company. The 10-kW transmitter is expected to be brought into service next February.

"Radio Communication," our Massachusetts contemporary, which was formerly published under the titles of *FM*, *FM Radio-Electronics* and *FM-TV* (which is still incorporated in its full title *FM-TV the Journal of Radio Communication*) now incorporates the journal *TeleVision Engineering*.



CINEMA-TELEVISION.—Some of the equipment installed by Cinema-Television in the Odeon Cinema, Leicester Square, London, W.C.2, for the large-screen projection of television. E.M.I. 6-lens-turret cameras and associated equipment is employed in the studio.

American Radio Engineers.—A graph in the American I.R.E's annual report, giving the trend of membership since 1912, shows how steeply the curve has risen since the entry of the U.S.A. into the war. In 1941 the membership was a little over 6,000; at the end of last year it was 29,408.

British Gear for Yemen.—Equipment which will form the nucleus of the first permanent internal and external communication system in the Kingdom of Yemen—74,000 sq mile

territory on the eastern shore of the Red Sea—has been ordered from Marconi's. The installation includes two 100-watt s.f. transmitters for internal services, 100-watt "Oceanspan" transmitter for communication with shipping in the Red Sea, and a 200-watt station for external working. Associated receivers are also being provided by Marconi's.

Export Enquiry.—Quotations in dollars (c.i.f.) for amplifiers, loudspeakers and record changers are wanted by Sight and Sound of 1320, Sixth Avenue, Seattle, Washington, who would be prepared to act as distributors for the eleven Western States. Offers should be sent direct to the company, but if copies are sent to the British Consulate-General, 1814, Exchange Building, Seattle, 4, Washington, it will enable the enquiry to be pursued.

TRAINING

Engineering Research Fellowships are to be awarded annually by B.T.H. to selected Honours graduates who are in their last year of apprenticeship with the company. The holder of a Fellowship will engage in engineering research for from one to three years at a university and/or at B.T.H. One of this year's recipients is P. C. McNeill who served during the war with R.E.M.E. and, when demobilized with the rank of captain, studied at Queen's University, Belfast. His research will be on secondary emission coefficients in magnetrons. The other recipient is P. H. G. Allen whose research will be concerned with heat flow in large transformers.

New Prospectus.—Full-time and part-time day courses in radio, radar and electronics are outlined in the Northern Polytechnic prospectus 1952/53, which also includes five evening courses embracing telecommunications engineering, radio and television servicing and electronics in industry. The prospectus is obtainable from the Northern Polytechnic, Holloway, London, N.7.

Amateur Radio Classes will again be held this autumn at the Wembley Hill Evening Institute (Middx) to prepare candidates for the C. & G. Radio Amateurs' Examination. They will be held on Mondays 7-10, the first hour being devoted to morse and the last two hours to theory. Enrolment will take place at Park Lane School, Park Lane, Wembley, Middx, each evening during the week 15th-19th September.

Radio Course for Teachers.—Another vacation course for teachers of radio and television has been arranged jointly by the Ministry of Education and the R.I. Council for the week beginning 8th September at the Borough Polytechnic, London, S.E.1. The programme includes, in addition to lectures on such diverse subjects as "The Servicing Examinations" and "Projection Television," visits to valve, receiver and component factories and B.B.C. studios.

BUSINESS NOTES

Baird.—It is proposed to change the name of Scophony-Baird, Ltd., to Baird Television, Ltd., at the extraordinary general meeting on 30th July.

R.G.D.—When the Automatic Telephone and Electric Co. took over the Radio Gramophone Development Co. twelve months ago it was stated that the subsidiary would be employed principally in meeting defence requirements for radio and associated equipment. It has now been decided to continue these operations at the Bridgnorth factory under the new name of A.T. & E. (Bridgnorth), Ltd. That part of R.G.D. concerned with the manufacture and sale of domestic radio and television gear has been taken over by William Harries, and the new Radio Gramophone Development Co. will operate from 3 and 4, Rampton Court Parade, East Molesey, Surrey (Tel.: Molesey 4357). Mr. Harries, the new chairman and managing director of R.G.D., holds similar positions at Regentone Products. A service depot is being maintained at 27, St. Mary's Street, Bridgnorth, Salop.

Bush Radio, Ltd., announce that C. C. Moore has been appointed assistant managing director and H. C. Baker, W. T. Deuchrass, W. H. Harrison and G. P. Wickham Legg have become directors of the Company.

Marconi Marine.—A. E. H. Boaz, who entered the Marconi Co.'s service as a sea-going radio operator in 1917, and since 1930 has been at the Grimsby depot, latterly as deputy manager, has been appointed manager of the Falmouth depot.

Metals Division of the Telegraph Construction and Maintenance Co. is to move from the Telcon Works, Greenwich, to the satellite town of Crawley, Sussex, where a new factory for the production of the company's special alloys used in the electrical, radio and communications industries is to be built.

Ferguson transmitters and receivers to the value of $2,500,000 have been ordered by the United States Government for N.A.T.O. aircraft.

Foreign Vessels being equipped by the Marconi Marine Co. with radio communication equipment and navigational aids include the 16,500-ton Chilian tanker *Sonap*, built at Antwerp, and a 7,850-ton bauxite and oil-carrying vessel for a Canadian shipping company.

Reductions in the prices of H.M.V. and Marconiphone television and radio receivers, varying from £2 17s 6d to 65 gns. (including purchase tax) are announced by E.M.I.

E. K. Cole are to provide new v.h.f. ground-to-air communication equipment for the airport at Guernsey, Channel Islands.

Philips have recently installed sound-reproducing equipment at the Betteshanger and Chislet Collieries in Kent.

NEW ADDRESSES

R.C.E.E.A. Moves.—The Radio Communication and Electronic Engineering Association, one of the four constituent bodies of the R.I.C., has moved from 59, Russell Square, London, W.C.1, to 11, Green Street, London, W.1 (Tel.: Mayfair 7874/5).

G.R.S.E.—The new secretary of the Scottish Area of the Guild of Radio Service Engineers is J. F. Barrie, 2, Willowbrae Road, Edinburgh.

Furzehill Laboratories, of Boreham Wood, Herts, which was founded by J. H. Reyner, the well-known author and consultant in 1927, have opened a new laboratory and production unit at Cheltenham.

Addison Electric Co., makers of test and measuring instruments, have moved their offices and works to new premises at Bosworth Road, London, W.10 (Tel.: Ladbroke 4280). A showroom will be retained at the old premises at 163, Holland Park Avenue, London, W.11 (Tel.: Park 6760).

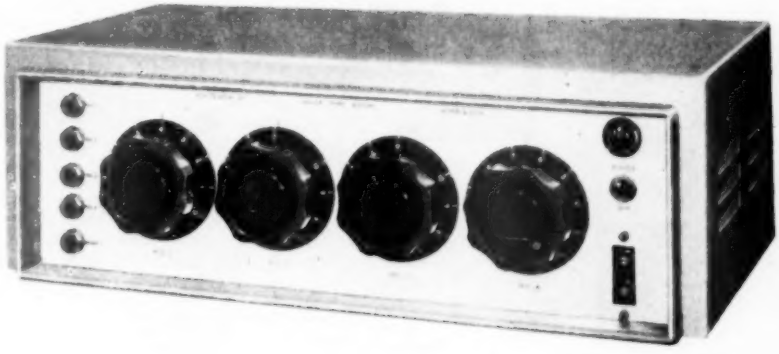
L. Glaser & Co., the instrument repairers, are now operating from 96-100, Aldersgate Street, London, E.C.1 (Tel.: Monarch 6822).

Stanley Sound and Vision Products are now at Lower Street, Haslemere, Surrey (Tel.: Haslemere 1426).

Whiteley Electrical Radio Co. advise us that their London showrooms at 109, Kingsway, W.C.2 (Tel.: Holborn 3074), are now open on Saturdays from 9 to 12.

RADIO on the new cable ship "Stanley Angwin" which Cable & Wireless Ltd. put into service last month. She is to be stationed at Singapore. The Marconi equipment shown is (L to R) "Worldspan" and "Oceanspan" transmitters, "Reliance" standby transmitter, shortwave and m-f-wave receivers between which is the remote control for the aerial splitter installation. Radar and echo-sounding gear was supplied by Kelvin & Hughes. D. A. Sydenham is the Radio Officer.

FOUR-WAY ELECTRONIC MIXER



This unit has 4 built-in, balanced and screened microphone transformers, normally of 15-30 ohms impedance. It has 5 valves and selenium rectifier supplied by its own built-in screened power pack: consumption 20 watts.

Suitable for recording and dubbing, or large P.A. installations since it will drive up to six of our 50 watt amplifiers, whose base dimensions it matches. The standard model has an output impedance of 20,000 ohms or less, and any impedance can be supplied to order.

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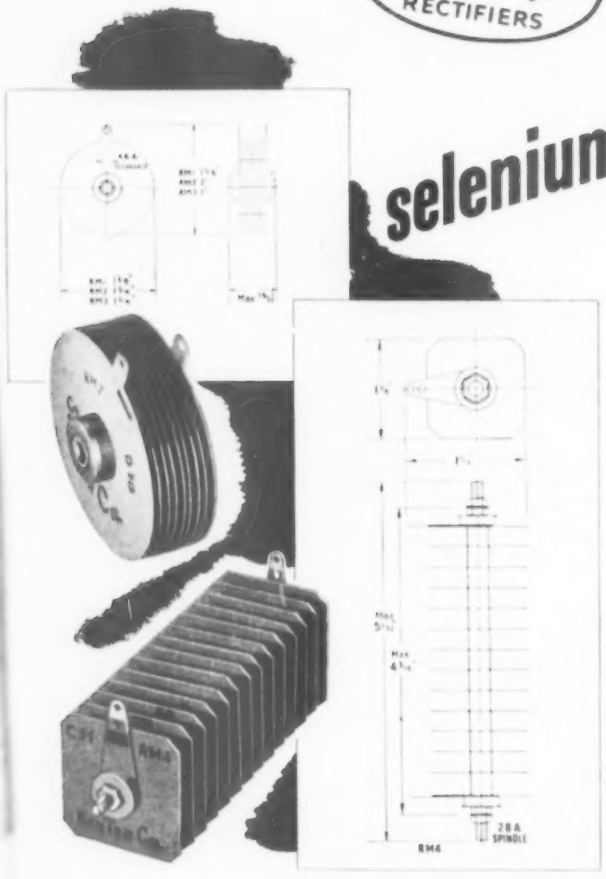
10 advantages of SELENIUM SenTerCel RECTIFIERS miniature selenium rectifiers



Compare these outstanding features with those of the rectifiers which at present you are using :—

- **Less wiring**
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- **Far lower heat dissipation.**
- **No "warming-up" period.**
- **No valve-holder.**
- **Practically indestructible in normal service.**
- **No limit to size of electrolytic capacitor.**
- **Saves weight.**
- **Saves space.**
- **Low in cost.**

Study these **RATINGS**

TYPE	RM1	RM2	RM3	RM4
Maximum ambient temperature	35°C 55°C	35°C 55°C	35°C 55°C	35°C 40°C 55°C
Maximum output current (mean)	60mA 30mA	100mA 60mA	120mA 90mA	275mA 250mA 125mA
Maximum input voltage (r.m.s.)	125V	125V	125V	250V
Maximum peak inverse voltage	350V	350V	350V	700V
Max. instantaneous peak current	Unlimited	Unlimited	Unlimited	Unlimited
Weight	1 oz.	1.4 oz.	2 oz.	4.5 oz.

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Faulty Interlacing

(*Concluded from p. 254 of the previous issue*)

A New Sync Separator Circuit

By G. N. PATCHETT,* Ph.D., B.Sc., A.M.I.E.E., M.I.R.E., A.M.Brit.I.R.E.

CONTINUING the investigation, a thyratron time base as shown in Fig. 12 was next tried. When the time base was fed with ideal positive sync pulses from the pattern generator, interlace was found to be perfect and it was impossible to get the time base to run with partial or even complete lack of interlace. The time base was now fed from the same differentiating circuit and limiter as used for the blocking oscillator time base, but a phase reverser (with unity gain) was placed between the limiter and the time base in order to obtain the correct polarity (positive) pulse. It was found that failure to interlace was due to:

(1) Differences in the triggering instant as shown in Fig 13(a), where the time base is triggered by the trailing edge of two different half line frame pulses.

(2) Differences in the end of the frame pulse. This is shown in Fig 13(b) and (c), where the flyback is shown interlaced but owing to different pulses on odd and even frames, two scans are produced similar to those of the blocking oscillator. It is fairly easy to see how some of the sync pulse may be fed to the output in the case of the blocking oscillator, since there is a direct connection (through the transformer) from the anode to the output terminals. With the thyratron it is not so easy to see how the pulse is transferred from the grid to the anode circuit, since when the time base was not synchronized, the flyback was completed long before the end of the frame sync pulse period. No pulses could be detected in the output with either the h.t. or heater disconnected, so that the effect was not due to capacitance. The answer was found by applying the ideal pulse from the pattern generator and varying the amplitude. Fig. 13(d) shows the output at the end of the flyback with a small sync pulse, when the flyback is completed rapidly; Fig 13(e) shows the effect when a large sync pulse is applied, the pulse ending at X in both cases. It is now seen that the thyratron is maintained in a conducting state due to grid current, the pulse on the grid being sufficiently large to maintain an arc between grid and cathode and so prevent the current in the anode circuit from ceasing. In this way the pulses are transferred to the anode and the output circuit. The effect can be reduced by reducing the magnitude of the sync pulses to the valve to about the magnitude of the standing bias, but then the time base is more critical to correct frequency setting.

Although the differentiating circuit gives a pulse with a sharp leading edge this does not mean that it will produce a correctly interlaced picture and, as has been shown, careful adjustment of the time base frequency control and limiter is necessary. In practice these settings are unlikely to remain fixed over a period of time.

The next type of sync separator tried was the integrator circuit. As has already been mentioned the start of the pulse obtained from this circuit is different on odd and even frames. With a simple integrator feeding the blocking oscillator time base (on the grid) it was found that partial interlace

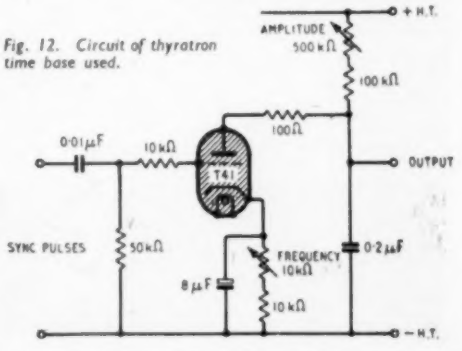


Fig. 12. Circuit of thyratron time base used.

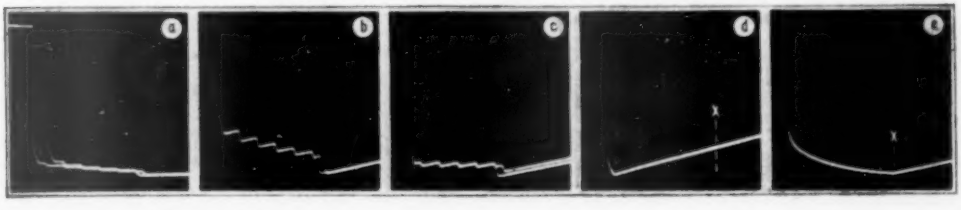


Fig. 13. Oscillograms during the flyback of the thyratron time base. (a), (b) and (c) synchronized from differentiating circuit, (d) and (e) synchronized from ideal pulse.

* Bradford Technical College.

normally occurred and correct interlace could only be obtained with critical setting of the frequency control. The partial interlace occurred because of incorrect triggering of the time base, due to differences at the start of the pulse. As the frequency control is varied the voltage to cause triggering varies and the triggering point moves up and down the leading edge of the pulse. As can be seen from Fig. 8 the difference in the leading edges varies up the pulse, being worst on line AB and small on line CD, and hence the degree of interlace varies. This difference in the leading edge can be reduced to negligible proportions by obtaining a large pulse and using a small time constant so that a large rate of rise occurs. In order to remove the line pulses, which are also increased by a small time constant, a limiter is usually necessary.

The integrator was now followed by an amplifier limiter so as to remove the line pulses and obtain a pulse with identical leading edges on odd and even frames. The output from this circuit was negative and therefore fed to the anode of the blocking oscillator. It was still found that partial interlace was easily obtained and the reason is shown in the end-of-flyback oscillograms Fig. 14(a) and (b). It is seen that in (a) the interlace fails because of the differences in the end of the sync pulse on odd and even frames. In (b) the interlace presumably fails because of slight differences in the peaks of the pulse, causing the valve to cease conducting at different instants, on the two frames. The latter effect may be overcome by clipping the top of the pulse before applying it to the time base. It was found that much better interlacing could be obtained by following the integrator (with a large pulse output) by a double clipper (as developed by a well-known firm and used in many commercial sets) so that a small "slice" of the integrated pulse is used. The start of the pulse is shown on a large time scale in Fig. 15(a) and the end of the pulse in (b). Increasing the time constant of the integrator circuit by a factor of three gave the results shown in Fig. 15(c) and (d). The effect of increasing the time constant is to reduce the rate of rise at the start of the pulse and, in this case, to produce two distinct traces. The effect on the end of the pulse is, in this particular case, the opposite, owing to the selection of a different "slice" of the integrated pulse.

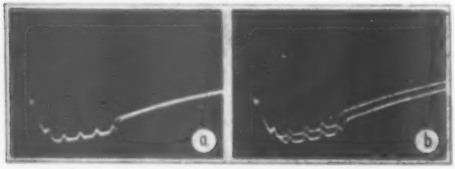


Fig. 14. Oscillograms of flyback of blocking oscillator when synchronized from integrator circuit.

Fig. 15. Pulse from integrator and double limiter. (a) and (c) start of pulse, (b) and (d) end of pulse, (c) and (d) with the time constant increased by a factor of three.

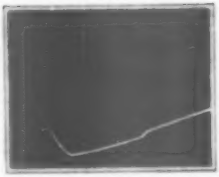
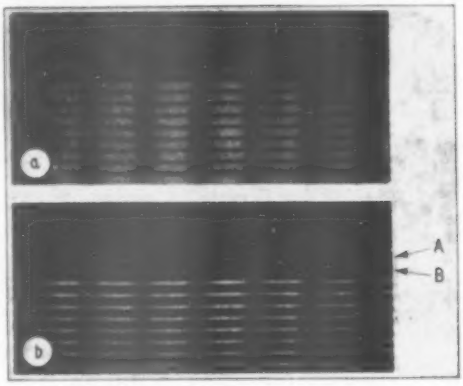


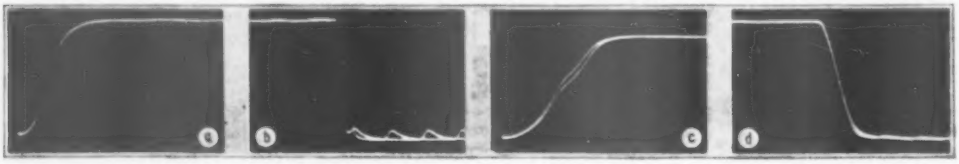
Fig. 16. Output waveform of blocking oscillator when synchronized on the anode from the pulse shown in Fig. 15.

Fig. 17. Photographs showing the displacement of one frame relative to the other.



From this it is obvious that the value of the time constant is rather important in relation to the remainder of the circuit. When the circuit was used to feed the grid of the blocking oscillator time base (with a positive pulse) interlacing was good, but when the pulse was reversed and fed to the anode (with the same amplitude) the result was not as good, but better than the other cricuits. Although no trace of the pulse could be seen on the output when the pulse was fed to the grid, a small "dent" on the scan waveform could be seen (Fig. 16) when the pulse was fed to the anode. This was not sufficient to be able to distinguish two scans (as shown, a difference of only 0.05 per cent is sufficient to upset the interlace) but was probably the cause of the interlace not being as good when the sync pulses were fed to the anode. Similar results were obtained using the thyratron time base, and with the double limiter good interlace was obtained. From this it is seen that the simple integrator circuit is not good, but when followed by amplification and double limiting satisfactory results can be obtained, provided care is taken in the design of the circuit.

It will be noted that in Figs. 11(e), 13(c) and 14(b) the differences in the scans are large, much larger than the half line necessary to cause normal lack of interlace. It was found that it was possible to obtain nearly perfect interlace, but with a line-and-a-half difference on odd and even frames, instead of half a line. This is shown in Fig. 17(a), which is the start of the horizontal



white bar of a test pattern. It will be seen that one line of one of the frames is displaced by approximately one line from its correct position. Fig. 17(b) is another example, although not interlaced, showing a displacement of approximately two lines, the white lines of the odd and even frames being superimposed on all but the lines A and B. Although this is perhaps not very normal, it does occur with certain settings of the limiter and time base frequency control and is reasonably stable. The result is, of course, a lack of vertical definition.

Owing to the possible number of variations it is impossible to try all the combinations, since, as has been shown, whether a circuit interlaces correctly or not depends very much on the amplitudes and component values, as well as on the circuit itself. It is therefore difficult to say whether one circuit is better than another without exhaustive tests. The author has not tried these two sync separators on other time bases but it is felt that, in general, similar results would be obtained. The author has tried synchronizing various blocking-oscillator time bases, a multivibrator time base and a Miller integrator transitron time base with ideal pulses from the pattern generator and perfect interlace was obtained in all cases. It appears, therefore, that failure to interlace is due to the differences in the frame pulses from the sync separator and not in the time base itself. Cocking has stated* that he found difficulty in obtaining correct interlace from a Miller integrator and a blocking oscillator using a pentode with the discharge circuit in the anode. One circuit of the first type and two variations of the latter were tried and correct interlace was obtained when fed with ideal pulses.

In order to obtain correct interlace it would appear to be essential that the sync pulse obtained from the sync separator should:

(a) Have a sharp leading edge with a fixed time delay to the first frame pulse, this time delay being identical on both odd and even frames.

(b) Be identical in all respects on odd and even frames. The ideal pulse would be one of very short duration, say 10-20 microseconds, so that it would not affect the flyback of the time base. It is possible to obtain such a pulse by using a flip-flop circuit, but this is complicated and not really necessary so long as the above conditions are satisfied.

A circuit producing pulses which are identical on odd and even frames is shown in Fig. 18. This circuit is fed with negative going pulses so that V_1 is cut off during the pulse and C_1 discharges through R_1. Between pulses C_1 is charged to the full h.t. voltage. On line pulses C_1 only discharges a small amount and the cathode of V_2 does not fall below its anode potential and hence there is no output. During the longer frame pulses C_1 discharges further until V_2 becomes conducting, and the output then follows the potential of C_1 up to the end of the pulse. Fig. 19(a) shows the voltage across C_1 and (b) the output voltage obtained from this circuit when viewed on a 50-c/s time base. It will be seen that the output waveform is identical on odd and even frames but that the leading edges of the pulses are not sharp.

In view of the fact that the simple sync separator circuits leave much to be desired, the author set about to develop a circuit which would fulfil the above requirements and yet be simple and inexpensive. The circuit of the resulting sync separator is shown in Fig. 20, which operates on the Miller integrator principle. A negative going video signal (positive sync pulses) is fed to the suppressor grid through the capacitor C_1. The signal is d.c. restored by half of the double diode valve V_2 so that the whole waveform is negative, as shown. During the period between pulses

Fig. 18. *Frame sync separator circuit.*

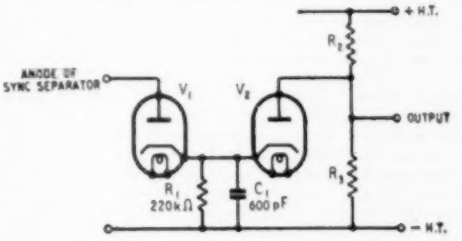


Fig. 19. *(a) voltage across C_1 in Fig 18. (b) output voltage.*

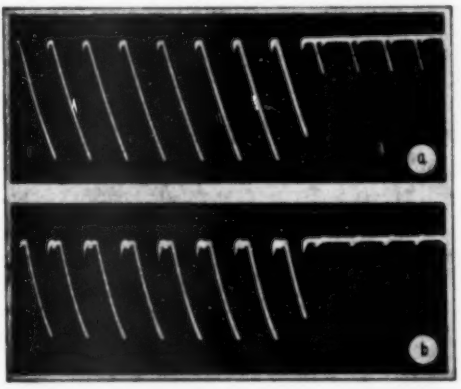
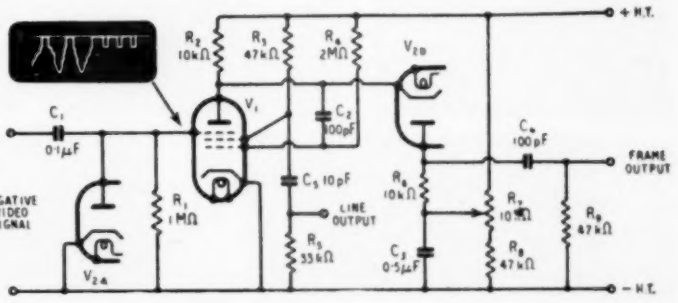


Fig. 20. *Circuit of new sync separator. V_1 = 6F32 or 6F33, V_2 = D63 or similar.*



* *Wireless World*, April 1947, p. 124.

the suppressor grid is driven sufficiently negative to cut off the anode current, and the anode, therefore, rises to full h.t. potential and C_2 becomes charged to the full h.t. voltage by the flow of grid current. During a pulse the suppressor grid is at approximately zero potential and the anode conducts. As the anode current increases and its potential drops, it drives the control grid negative through the capacitor C_{2a}, thus tending to reduce the anode current. An equilibrium condition is soon reached after an initial drop in anode potential. The capacitor C_2 then gradually discharges during the pulse through resistors R_3 and R_{2a}, and the anode potential falls linearly owing to the Miller feedback action. At the end of the pulse the suppressor grid in driven beyond cut-off and C_2 recharges to full h.t. voltage. During the short line pulses the fall in anode potential is small, but during the longer frame pulses the fall is four times as great (neglecting the initial drop in anode potential).

Fig. 21(a) shows the waveform (on a 50-c/s time base) at the anode during the frame synchronizing period. The half of the double diode $V_{2a,b}$ is biased by R_3 and R_4 so that it only conducts on frame pulses. The resulting voltage across R_4 is shown in Fig. 21(b). This waveform is identical on odd and even frames but has no sharp leading edges. The waveform is now differentiated by C_3 and R_5, the result being shown in Fig. 21(c). During the slow fall in potential of the pulse across R_4, an approximately constant negative voltage is obtained on differentiating, but, on the sudden charge of C_3 at the end of the pulse, a sharp positive pulse is produced on differentiation. Fig. 21(d) shows the start of the frame synchronizing period on a larger time scale, where it will be noted that an exceedingly sharp leading edge results—so sharp that it fails to record on the oscillogram. It will also be seen that there is only one trace for odd and even frames. The leading edge of the first sharp pulse corresponds to the end of the first frame pulse and is, therefore, rigidly fixed in time relative to the start of the first frame pulse. Fig. 21(e) is the output at the end of the frame pulse period, again showing identical pulses for odd and even frames, the exposure for this oscillogram being 1 second on a 50-c/s time base. The output from this sync separator therefore fulfils the conditions set out earlier.

Since the control grid is driven negative during the pulse periods, an output is also available from the screen grid across the resistor R_3. This consists of positive pulses, and the screen grid voltage during the frame synchronizing period is shown in Fig. 22(a), where it is seen that pulses are produced with a sharp leading edge. Fig. 22(b) shows the output from the screen grid after differentiation by C_4 and R_6, the oscillogram being taken on a 10-kc/s time base. Again there is an excellent positive sync pulse.

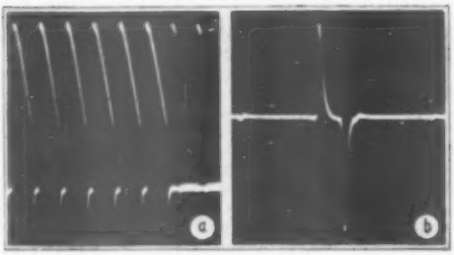
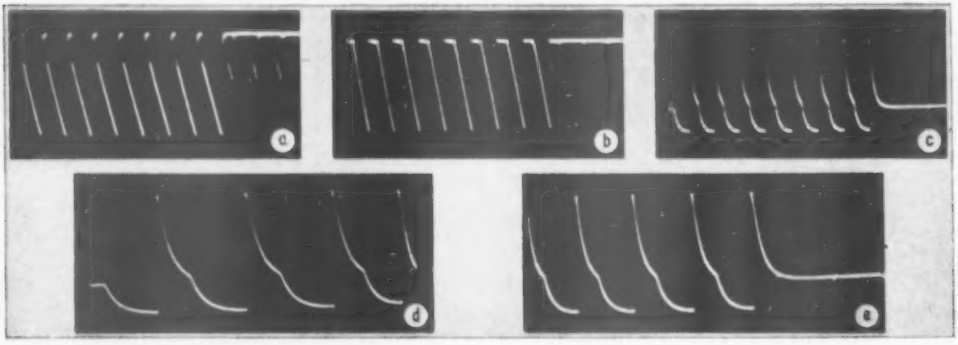


Fig. 22. Waveforms on new sync separator. (a) voltage on screen grid during frame pulse period (50-c/s time base). (b) voltage across R_6 (10-kc/s time base).

Tests using this sync separator with a thyratron time base gave perfect interlace, and it was found impossible to get the time base to come out of perfect interlace. The same result was obtained when using a blocking oscillator time base. Fig. 23(a) shows a portion of Test Card C using this sync separator, where perfect interlace is seen. Fig. 23(b) shows a photograph of a portion of the screen during the morning transmission of the test film (not the Test Card C portion but the portion with moving pictures). This is a 3-*minute* exposure, so that no picture is obtained, but it shows the excellent interlace and rigidity of the line structure. Both photographs were taken on a commercial set (with the frame time base replaced with this sync separator and the thyratron time base) operating near the centre of a large city. Fig. 4(b) was taken with the same set, using the normal sync separator and line time base (consisting of an integrator—with double limiter—and blocking oscillator-time base) and 4(a) with the above sync separator and thyratron time base. These two photographs show the great reduction in line structure obtained by correct interlace.

Since the suppressor grid must be cut off between

Fig. 21. Waveforms of new sync separator. (a) anode voltage, (b) voltage across R_4, (c) output voltage, (d) output voltage at start of frame pulse period, (e) output voltage at end of frame pulse period. All on 50-c/s time base.



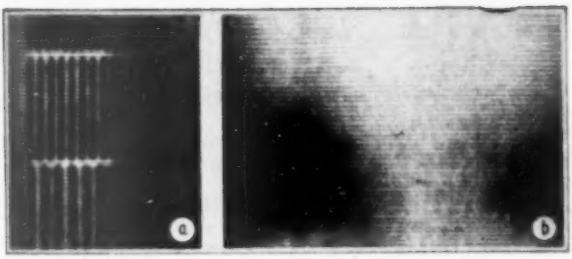


Fig. 23. Photographs of portion of raster using new sync separator. (a) portion of Test Card C. (b) 3-minute exposure of moving picture.

pulses the valve V_1 must be of the short-base suppressor grid type, such as a 6F32 or 6F33 (the 6F33 has an internal diode connected to the suppressor grid and the half diode $V_{1(2)}$ is not required). The author's tests were taken with a 6F32 (VR116), which is more readily available. With a 250-V h.t. supply the minimum value of the sync pulses for correct operation is about 6 volts peak-to-peak, and with 150-V h.t. about 3.5 volts peak-to-peak. The sync pulse amplitude available varies from set to set and, of course, with contrast, but the normal minimum value appears to be about 6 volts peak-to-peak. If the sync pulses are smaller the sync separator must be operated on the lower value of h.t. The magnitude of the sync pulses available is about 10 volts peak-to-peak for the frame and at least 15 volts peak-to-peak for the line (this depends on the capacitance loading the differentiating circuit and is difficult to measure accurately). These figures are for a 150-V h.t. supply and are increased for 250-V h.t.

Apart from the sync separator producing excellent interlace, it is very simple and uses few components. It must be remembered that it also separates the picture from the sync pulses (being fed with a video signal), whereas with the other circuits described the picture must be removed in a separate picture sync separator. Figs. 22 and 23 were all taken with the sync separator fed with a composite video signal. The circuit only requires two valves (one a double diode), five small capacitors and nine resistors of small wattage. Actually C_1 and R_6 may be omitted and the output taken from the tap on R_7 through C_1 and R_6 with only slight alteration in performance. R_8 and R_9 are also commonly part of the time base and should not really be included. A well-known integrator circuit with double limiting uses two valves (one pentode and half of a double triode), seven capacitors, ten resistors and one choke. The new sync separator therefore compares favourably and has no critical adjustment, the only adjustment being R_7, which, once set, should need no further attention. None of the component values is at all critical.

A sync separator of this type has now been in use over a period of several months, giving excellent results. It is impossible to see the lines on a 12-in tube when more than about two feet from the screen (much nearer than the tube would be viewed in practice), except occasionally on a moving picture when the two sets of lines *appear* to split up, as the eye follows a moving object. This difficulty is inherent in any interlaced picture and is nothing to do with failure of interlacing.

Although the sync separator does produce perfect interlace it must be remembered that the interlace can also be upset by line pulses injected directly into the frame time base circuit which have nothing to do with the sync separator. Reasonable care is therefore necessary in the layout and screening to prevent this. The effect did occur in one of the sets constructed using this sync separator, where the interlace was found to be good but not quite perfect. The trouble was cured by fitting a screen between the line output stage and the frame time base.

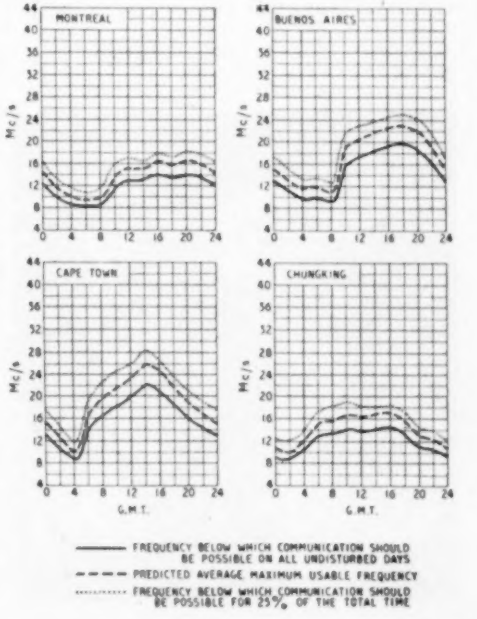
In view of the number of ways in which interlace may fail it is not surprising that few sets produce a perfectly interlaced picture. It is the opinion of the author that if really correct interlace were present on a greater number of sets, less would be said about the need for a greater number of lines with the attendant difficulties and increased costs. With a correctly interlaced picture it is quite impossible to see the lines of a 12-in tube from any normal viewing distance, but this is far from true when incorrect or no interlace occurs.

Short-wave Conditions

Predictions for August

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during August.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.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DUPLICATING TAPE RECORDINGS

New U.S. System for Quantity Reproduction

By DONALD W. ALDOUS

MAGNETIC tape is used today for the original recording of nearly all new commercial discs, which are then produced by re-recording from the edited master tape. An obvious extension of this technique is the production of tape copies by means of a similar re-recording process.

For broadcasting, educational institutions, Services' applications, as well as supplying recorded tapes for domestic entertainment, has recently grown an important demand for mass tape duplication.

Attempts have been made to gang together one playback and many recording machines, but the results have been unsatisfactory. Additionally, loading and unloading times are excessive and, as normal tape speeds are often used, the output in finished tapes is too low for the method to operate as an economic proposition. Another system is a "printing" process in which a virgin tape and the master tape are rolled together in close contact at high speed through a special magnetic head, thus producing a facsimile of reasonable quality.

A radically different approach to this problem has been adopted in the last few months by Dr. Francis Rawdon Smith, formerly of Cambridge, England, now an engineer and designer of electronic devices in Washington, D.C., in collaboration with L. S. Toogood, of the Toogood Recording Company, Chicago.

A common mandrel, powered by a large, synchronous motor, is used to drive all the tapes involved, both master and slaves. This enables copies to be produced which are equal in length to the master, with an accuracy of better than one inch in 1,200 feet. Thus, with standard tape speeds, the accurate timing essential for broadcasting is solved.

With this "Multitape" machine, shown in the accompanying illustration, forty half-hour tapes can be produced from one master in an hour, and these copies are virtually indistinguishable from the original.

"Multitape" duplicating machine being loaded by Dr. Rawdon Smith, one of the designers.

Practical Requirements

The mechanical arrangements of this machine are due to L. S. Toogood, but many difficult electronic problems had to be solved by Dr. Rawdon Smith before the final "Multitape" machine could meet the stringent requirements of its co-designers. Examples of these problems are (a) the provision of bias for as many as twelve channels, necessitating an unusually high-powered bias source; (b) as it is desirable to run the tapes very fast, to increase production, special equalization is necessary; (c) the high tape speed necessitates a very high bias frequency, otherwise the recorded bias might fall in the audio range when the tape is played back at low speed; (d) this very high bias frequency also makes it necessary to use heads with extra thin laminations which, in turn, increases head wear unless special materials are used, and tape tension is low.

Still another problem in multiple tape duplication arises from the fact that not all playback heads on the diverse reproducing equipment used are always in perfect alignment. A novel design of head has been developed to reduce the sensitivity of the tape copies to playback head azimuth misalignment.

This highly specialized equipment has been exhaustively tested for fidelity of the duplicates to the original, for freedom from introduced harmonic distortion, and particularly for any increase in wow or flutter content in the copies. It is claimed that, with each channel in proper adjustment, copies are produced of such a standard that when *any* copy is spliced at the appropriate point to the master tape, it is impossible to detect the changeover, even on the highest fidelity channel.

"DECALS"

THE above expression seems to be the modern name for the once-popular "transfer," well known some two decades ago. In the form now produced by Alexander Equipment, Ltd., Child's Place, Earl's Court, London, S.W.5, the transfers provide a bold white lettering, ¼in high, for marking control panels and the like.

The transfers are supplied as a book containing six pages totalling some 500 different markings and each page applies to a particular branch of radio or electronics. Page 1 covers communication, amateur radio and audio equipment; page 2 television and oscilloscopes; page 3 radar and pages 4, 5 and 6 industrial electronics and general purposes. Books cost 4s 9d each.

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Series or Parallel?

Thoughts on the "Clapp" and Other Oscillator Circuits

By "CATHODE RAY"

SOME considerable while ago* I remarked on the possibility of dispute as to whether circuit elements are in series or in parallel. An example of this actually occurred recently. One eminent authority stated that in a valve oscillator the maintaining system (i.e., the valve and its appurtenances) always took the form of a shunt (parallel) circuit across the tuned system; and another eminent authority objected, holding that there were oscillators in which the maintaining system was in series with the tuned circuit.†

When originally discussing the general series-or-parallel question I said that what settled the matter was the position of the generator. Two circuit elements connected as in Fig. 1 could, if nothing more were known about them, be considered as either in series or in parallel with one another. But if a generator is connected as in Fig. 2(a) there is no doubt about L being in series with C; while in Fig. 2(b) they are equally clearly in parallel with one another. Now in a valve oscillator L and C are the tuned circuit or frequency-determining system, and the valve, etc., is the generator. So it comes to deciding whether the valve generator is connected as at (a) or at (b) in Fig. 2.

This looks as if it ought to be quite easy. In most oscillator circuits there is little or no doubt that Fig. 2(b) applies. But what about the so-called Clapp circuit, Fig. 3?** In this it looks as if L and C are in series with one another and with the maintaining system. But it all depends on where you draw the line between the maintaining system and the tuned circuit. Where do C_1 and C_2 come in? If they are parts of the valve system, there is no doubt about it being a series circuit.

But, if a series circuit, how does it work? Most valve oscillators are essentially amplifiers with positive feedback. The feedback circuit is so arranged that only at one frequency is sufficient signal fed back to keep oscillation going. That is the object of the tuned circuit—it is the part of the feedback system that is responsible for weeding out all but the desired frequency. Now there are two conditions that decide whether oscillations can be maintained. One is that the total amplification round the system must be at least 1. That is, if you start at any point, say the valve grid, and reckon right round, through the amplifier and the feedback connection, back to the same point, the voltage received there must be at least equal to what is being put in to cause it. If the valve has a voltage magnification (at the desired frequency) of 20, then at least one-twentieth of it has to be fed back to the input. The other requirement is that the fed-back voltage must be exactly in phase with the input. This double condition is really pretty obvious: if you break the feedback connection and drive the valve from some independent source which gives, say, 0.5V at a certain

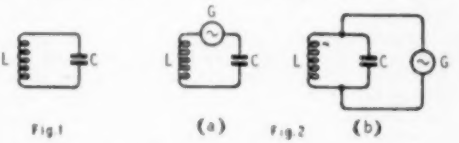
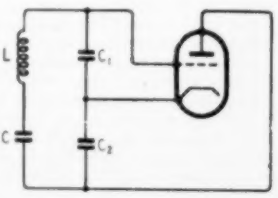


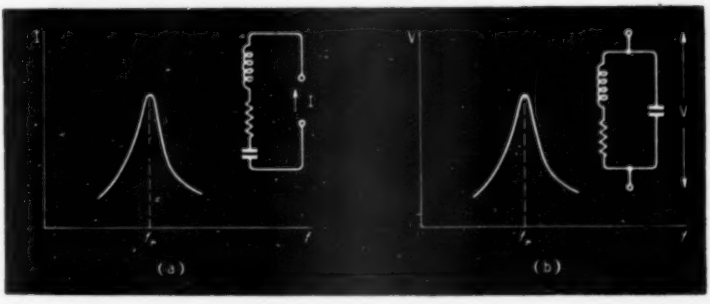
Fig. 1. Are L and C in series or parallel?

Fig. 2. The question in Fig. 1 is settled by the position of the voltage generator, G. In an oscillator, G is a valve circuit. Usually it is in parallel (b), can it ever be in series (a)?

Right: Fig. 3. Essentials of the "Clapp" circuit. Details like d.c. supplies, which might distract attention, have been omitted.



Below: Fig 4. Comparison between (a) series and (b) parallel resonance. The frequency at which resonance takes place is denoted by f_r.



* "Conventions and Viewpoints," Sept., 1946.

† *Wireless Engineer*, Dec., 1951, p. 374.

** I say "so-called" because G. G. Gouriet, of the B.B.C., seems to have a much earlier claim to it. Hereinafter, "Clapp circuit" is to be taken as meaning "so-called Clapp circuit."

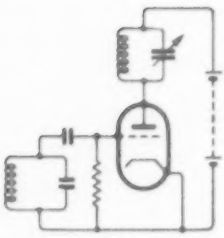


Fig. 5

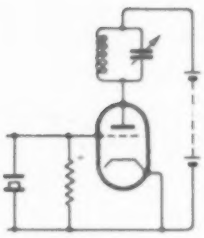


Fig. 6

Fig. 7

Fig. 5. Tuned-anode tuned-grid oscillator circuit, where the tuning circuits are obviously parallel.

Fig. 6. Typical crystal-controlled oscillator circuit, which should be compared with Fig. 5.

Fig. 7. Electrical equivalent of the crystal in Fig. 6. L is very large, C is very small, and both are extremely constant. C_1 is much larger than C, but of the same order as valve and stray capacitances, so is much affected by them.

frequency, and the resulting signal at the end of the feedback circuit happens to be 0.5V, in phase with the input, then it would make no difference from the valve's point of view if the fed-back signal were substituted for the independent signal, but it would mean that the valve would be acting as its own generator.

Tuned-anode Tuned-grid Circuit

Since a valve is a voltage-operated device—the grid responds to voltage, not current—the feedback or tuning circuit must be devised to have a *voltage* maximum at the desired frequency. So a series tuned circuit, which has a *current* maximum (Fig. 4(a)) seems to be quite the wrong medicine. Surely it would tend to cause oscillation at any *but* the desired frequency! What is needed is a parallel tuned circuit (b), with its voltage maximum. The great majority of oscillator circuits clearly support this general theory. I need hardly show examples, but Fig. 5 (the well-known tuned-anode tuned-grid circuit) is one. The feedback circuit is perhaps not too obvious, since its essential link is mainly the anode-to-grid capacitance of the valve itself, but there is no doubt about its parallel tuned circuits.

I chose the t-a.t-g. circuit on purpose, because it emphasizes the great and baffling crystal mystery. It baffled me for a long time, thanks to the unhelpfulness of so many books purporting to deal with the subject. Fig. 6 is a typical crystal-controlled oscillator circuit, which looks the same as Fig. 5 except that the quartz crystal takes the place of the grid parallel tuned circuit. The mystery arises when one is informed that the electrical circuit equivalent to the crystal is as in Fig. 7—an extremely high-Q high-L/C *series* resonant circuit, in parallel with C_1, which is the parallel capacitance of the plates—a few pF—to which, of course, must be added the grid capacitance of the valve, and sundry strays. The mystery is really two-fold. First, how can a t-a.t-g. circuit work with a series tuned circuit in the grid? Especially a very high-Q circuit, such as the crystal is alleged to be; surely it would short-circuit the grid to earth at the resonant frequency? Secondly, having concluded that it cannot be a series circuit, but must be a parallel circuit tuned by C_1, how can one account for the phenomenal frequency stability of this oscillator, seeing that C_1 is very far from stable, and is affected by every change in the valve and wiring?

One must, I suppose, give the specialist books on quartz crystals the benefit of the doubt by assuming that somewhere among their hundreds of pages of mathematics could be found the answer, if one were good at finding needles in haystacks. Most of the books on radio in general, however, provide all the ingredients of the mystery by publishing Fig. 7, and then display a masterly but tantalizing restraint by withholding the explanation. No doubt one ought to be able to work it out for oneself (and that is what I had to do in the end), but what are authors paid for if not to save one the trouble?

And again, what about "Clapp," whose tuned circuit bears an obvious similarity to Fig. 7, for its L and C preferably form a high-Q high-L/C circuit, with C_1 (and C_2) very much larger than C?

Well, first, the general-principle argument that because a valve is a voltage-operated device the tuned circuit must inevitably be one that gives a voltage resonance, that is to say a parallel circuit, doesn't hold water. A current peak can be converted into a voltage peak by passing the current (from the series tuned circuit) through an impedance. Reactance would affect the tuning, so let us call the impedance a resistance. Consider Fig. 8, for instance. The anode current of the valve flows through R_2, which is the output coupling resistance. Any alternating part of this anode current causes an alternating voltage across R_2, which, being in series with LC, produces a maximum current through LC when its frequency is f_r, the frequency of resonance. This a.c. causes a maximum voltage across R_1, and that voltage is applied to the grid. And does it cause oscillation at that frequency? No! At resonance, the impedance of LC is (theoretically) zero, so the alternating voltage at the grid must be the same as at the anode. But there is the usual phase reversal through the valve, between

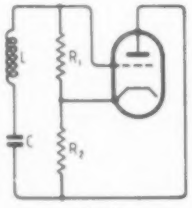


Fig. 8

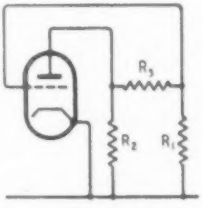


Fig. 9

Fig. 8. This attempt at a series-LC oscillator circuit breaks down for lack of phase reversal between anode and grid.

Fig. 9. Another way of drawing Fig. 8, showing the feedback circuit as a filter. At resonance L and C cancel out, leaving only a resistance (usually small), R_3.

grid and anode, so the fed-back voltage is opposite in phase to what is necessary for oscillation. Fig. 8 could be drawn in another way, showing the feedback circuit in conventional filter form (Fig. 9). In practice the impedance of LC at resonance is not entirely zero, but consists of the resistance of the coil, etc., shown here as R_s. So the feedback circuit (at f_r only, remember) is nothing more than a simple attenuator, giving no change of phase.

The necessary phase reversal to cause oscillation could be obtained by inserting a perfect transformer between R_1 and the grid (or between the anode and R_2). This is all right theoretically, but in practice a transformer, for r.f. at least, would be far from perfect, introducing so much reactance that it would have to be reckoned in with the tuning circuit.

Instead of a transformer one could use a second valve to get the phase reversal, as in Fig. 10. Maximum positive feedback would occur when the impedance between A and B was least, and purely resistive (i.e., no phase shift). This is exactly what happens at the series resonance of LC. The maintaining system, which is everything except LC, could be shut up in a box, with only the terminals AB for external connection. Connected in series with any reasonable series tuned circuit, it would generate oscillations at a frequency controlled by the L and C values of that circuit.

But again there is a practical snag, especially at high frequencies. The resistance coupling between the two valves is inevitably shunted by stray capacitive reactance (valve electrodes and so forth), which shifts the phase angle from zero. Since oscillation cannot take place unless the total phase shift right round the loop is zero, and there is an overall phase shift in the two-valve amplifier, what happens? Clearly, the zero-phase condition can only be fulfilled if the feedback-circuit (LC) has an equal and opposite phase shift. As we know, it is only exactly at resonance that it has zero phase shift. A rise in frequency (as we saw last month with our reactance sketches) makes LC equivalent to an inductance, which shifts the phase in one direction, and a fall in frequency makes LC equivalent to a capacitance, which shifts the phase the opposite direction. The lower the resistance of LC (i.e., the higher the Q), the smaller the frequency shift needed to bring about sufficient phase shift to cancel out the phase angle in the amplifier. So here we have an important conclusion—to minimize undesired frequency variation, use a high-Q tuned circuit. But however high the Q of LC, we cannot say that the frequency of the oscillator is controlled exclusively by the tuned circuit: it depends to some extent, even if only slightly, on stray capacitances and any other phase-shifting influences in the maintaining system.

Seeing that even in practical apparatus one probably could, at least over a limited range of frequency, arrange for the influence of the amplifier to be very small, it may seem like hair-splitting to bring this into the discussion, presumably in order to deny this system the right to be called a series-tuned oscillator. Even if the amplifier phase shift wasn't quite zero, and LC had to work a shade off resonance, what of it?

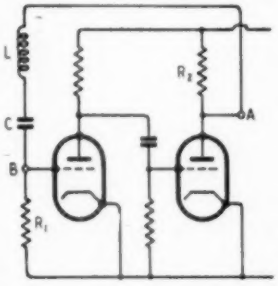
Well, where precise maintainance of frequency is concerned, splitting hairs is none too delicate an operation—in fact it is comparatively clumsy. Unintended frequency variations of even one cycle in a million cause concern, and the specialists at the job are beginning to think about one in a thousand millions. It is no use taking immense care to keep L and C constant if the frequency depends also on a whole lot of rather indefinite and variable quantities in the amplifier. Any ordinary oscillator varies noticeably in frequency if the h.t. voltage drops, due, say, to a heavy load on the power station. It wouldn't do at all if the oscillators controlling the frequencies of broadcasting stations behaved like that. So, adjusting our mood to one of high scientific precision, we must face the fact that in general, owing to phase shifts in the maintaining amplifier, a feedback circuit such as LC in Fig. 10 is not worked exactly at resonance, and therefore it is equivalent to *either* a coil *or* a capacitor. Assuming the former, for example, we have, as shown in Fig. 11, the amplifier in a box, with the coil equivalent to LC connected to the terminals AB. The other part of the frequency-determining system must be inside the box and presumably equivalent to a capacitor. So our series-tuned oscillator is beginning to look like a parallel-tuned oscillator!

Off-tune Oscillation

This line of thought can be developed more instructively by going back from Fig. 10, which is not a very familiar type of oscillator circuit, to the "Clapp," Fig. 3. Its resemblance to Fig. 8 is obvious. And that may at first be rather puzzling, for you will remember that we found Fig. 8 couldn't possibly oscillate, because there was no phase reversal to cancel that of the single-valve amplifier. How can substituting C, C_2 for R_1 R_2 make so much difference?

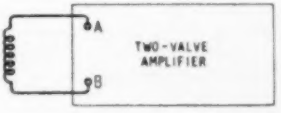
And that, as Hamlet remarked, is the question. If the frequency of oscillation were the frequency to which LC was tuned, it couldn't. LC would be a low resistance, as in Fig. 9, and substituting C, C_2 for R_1 R_2 wouldn't shift the phase by anything like the required 180°. In short, if LC were in tune the "Clapp" oscillator couldn't possibly work. Since, however, it does work it follows that the frequency of oscillation must be different from the frequency to which LC is tuned, and that LC alone is not sufficient to determine the frequency. Clearly an oscillation frequency below LC resonance wouldn't do, as reference to the appropriate reactance sketch shows that LC would be capacitive, and a three-capacitance network wouldn't have a hope of shifting the phase 180°.

But if you are *au fait* with filter theory, or can turn up my treatise thereon in the February, 1950, issue,



Left: Fig. 10. Here the necessary phase reversal is obtained by a second valve.

Right: Fig. 11. At frequencies above resonance LC in Fig 10 is equivalent to an inductance, so Fig 10 is equivalent to this.



Figs. 3 and 4, you will see that a simple low-pass section, as in Fig. 12 here, at its cut-off or resonant frequency shifts the phase 180°. And this is just what a "Clapp" circuit is, at frequencies above the resonance of its LC. If we redraw it back into its original (Fig. 3) form, we get Fig. 13, which we recognize at once as our old friend the Colpitts parallel-tuned oscillator circuit. L′ is the equivalent, at the frequency of oscillation, of LC in Fig. 3. When I say equivalent, I mean that you could calculate the impedance of the path LC in the "Clapp" circuit at the frequency of oscillation, find that it was an inductive reactance of a certain number of ohms, calculate the inductance needed to give that number of ohms at that frequency, wind a coil of that inductance, disconnect LC and substitute the new coil, and find that the oscillator would go on working at the same frequency as before.

Why, then, prefer Fig. 3 to Fig. 13? It needs an extra component, to say nothing of causing all this argument.

The answer is that L′ is equivalent to LC *only at the one particular frequency*. So although Fig. 13 is equivalent to Fig. 3 so long as the frequency remains exactly the same, the slightest change in frequency is enough to reveal the difference. LC doesn't behave as a constant inductance but as one whose value varies with frequency. It does so in such a way as to make any change in frequency less than it would be in the Fig. 13 circuit. This point calls for a little further explanation.

Advantage of the "Clapp"

The object of the "Clapp" circuit is to keep the frequency of oscillation as free as possible from the influence of the maintaining system. The idea is to determine it as much as possible by L and C, which are provided by components designed and constructed to be as constant and stable as possible; if necessary, kept at constant temperature in a thermostatically controlled box. In particular, the valve capacitances, which vary appreciably with the working voltages and currents, should be kept out of it. One way of minimizing the influence of a varying capacitance is to shunt it by a very much larger capacitance. If a 5-pF valve inter-electrode capacitance is liable to vary to the extent of 0.1pF, the variation is 2 per cent, which is serious. But if the 5pF is shunted by 5,000pF, the 0.1-pF variation is only 0.002 per cent of the whole. So the designer, in either Fig. 3 or Fig. 13, would tend to make C_1 and C_2 as large as possible. He would have another reason for doing so. If they were small, then the tuned circuit as a whole would have a high impedance, and, as it forms a coupling impedance, the valve's amplification would be much greater than was needed to maintain oscillation, and the oscillation would grow until the valve was very much over-driven, which would distort the waveform and increase variations in valve capacitances and consequently frequency. Still another adverse effect would be a considerable change in the equivalent shunt *resistance* of the valve, and (as is explained in treatises on resonance and equivalent series and parallel circuits) the frequency of a resonant circuit is affected by shunt resistance. So for all these reasons, C_1 and C_2 are made as large as they can be, subject to their reactance being sufficient to keep oscillation going at all. L′, for a given frequency, is, therefore, quite small. The L/C ratio, in other words, is as small as possible.

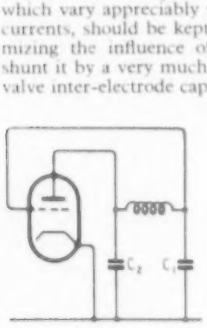


Fig 12

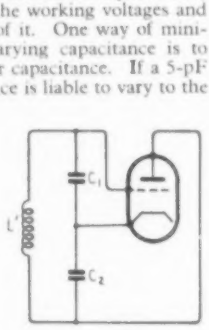


Fig 13

Fig. 12. At the frequency of oscillation, necessarily above that of LC resonance, the "Clapp" circuit is equivalent to this, in which LC (inductive) and C_2 C_1 form a filter section giving the needed 180° phase shift.

Fig. 13. At the working frequency of Fig. 3, which is necessarily higher than the frequency at which LC resonates, the circuit is equivalent to this. L′ is normally very much smaller than L.

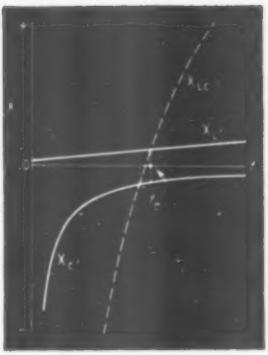


Fig. 14. Reactance sketches for L′ and C′ (equal to C_1 and C_2 in series) in Fig. 13, where C_1 and C_2 are preferably large, and L′ small, on the assumption that L′ is the inductance of a real coil and therefore constant. But if it is LC in Fig. 3, its reactance sketch is as X_{LC}, which has a much steeper slope.

How the use of LC in place of L′ is beneficial is a nice little example of the reactance sketching I advocated last month. First, since the reactances of L′ and its opposite number (mainly C_1 and C_2 in series), which one could appropriately call C′, are relatively small, we must sketch their curves close to the frequency axis as in Fig 14. Their resonant frequency, at which they are equal and opposite, is marked f_r, and (if the value of C′ takes account of the valve impedance) is the frequency of oscillation. Now if C′ varies slightly due to changes in the maintaining system, this would be represented in Fig 14 by the $X_{C'}$ curve moving nearer or farther from 0. Suppose C′ increases; then $X_{C'}$ must be moved nearer 0, and in order to maintain equality of $X_{C'}$ and $X_{L'}$ the point f_r must slide along a little way to the left. This represents the slight drop in frequency caused by the increase in C′, and pictures the action of Fig 13.

Now let us compare the action of Fig 3. The reactance curve of a path consisting of L and C in series is obtained by adding together those for L and C separately. If X_L and X_C are made very much larger than $X_{L'}$ and $X_{C'}$, their separate curves, and consequently the X_{LC} curve, will be very steep, as shown dotted in Fig 14. Since LC is equivalent to L′ at f_r, its curve must coincide with the $X_{L'}$ line at that frequency. And now we see the difference between the Colpitts and "Clapp" circuits very clearly.

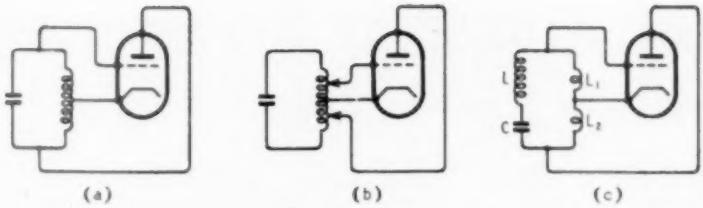
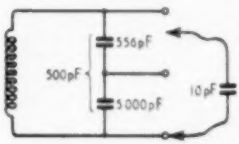


Fig. 15 (a) is the Hartley circuit in its simplest form ; (b) is a tapped-down variety, which can be redrawn as (c), for comparison with Figs. 3 and 8.



Right : Fig. 16. Showing how tapping 10pF across one tenth of the capacitive tuning reactance affects the resonance frequency one hundredth as much as when it is connected across the whole.

Even on the absurd supposition that C′ strayed right up to infinity, the most that the frequency of oscillation could change is represented by the little fragment of f axis between f_r and the point at which it is crossed by the X_{LC} curve. Below that, LC becomes capacitive. Since in any well-designed practical oscillator the biggest change in C′ would be a very small fraction of 1%, the change in frequency needed to bring X_{LC} again to equality would be ultra-microscopic. Hence the merit of the scheme. If at f_r the X_{LC} curve is 100 times steeper than the X_L and X_C curves (as can easily be), the frequency is 100 times as stable as the already quite good low-L/C Colpitts circuit from which it has been adapted.

In a crystal-controlled oscillator, L, the equivalent series inductance of the crystal, may be many *henries*, and C is only hundredths of a pF, so the L/C ratio is enormous, and the line is almost vertical. So it doesn't affect the frequency much even if C_1 (which, although small by ordinary standards, is vastly greater than C) varies widely. We have the curious paradox that although C_1 is the capacitive half of the parallel tuned circuit, the frequency depends very little on it and almost wholly on LC, simply because LC is equivalent to a wide range of inductance (to balance C_1) within an extremely small range of frequency. To a less extent this is true also of "Clapp" tuning.

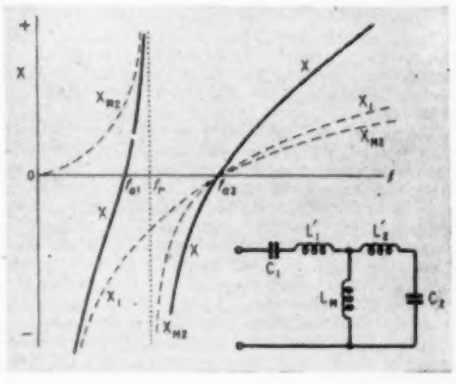
Summing up, one can say that the answer to the series-or-parallel question depends on how the tuned circuit is defined. If it is reckoned as the circuit that is in resonance at the frequency of oscillation, then the first eminent authority is right. If it is reckoned as the circuit that *mainly* decides the frequency of oscillation, regardless of whether it is in resonance or not, then the second is right. Note that the second view is necessarily an approximate one, for the series circuit doesn't exclusively determine the frequency—the parallel element has some say in the matter. But for any except very precise work the effect of the parallel element can, by good design, be made negligibly small. So for practical purposes the tuning is effected by a series circuit or its crystal equivalent. You can incline either one way or the other, according to whether you are theoretically or practically minded.

Personally I incline to look on the "Clapp" type of circuit as a tapped-down or loose-coupled Colpitts, and therefore a variety of conventional parallel tuning. It is well known that the simple Hartley circuit, Fig. 15(a), is improved if a high-Q tuning circuit has the maintaining valve tapped across only a part of it, as at (b). To emphasize the similarity to Figs. 3 and 8 we can redraw this as at (c). Fig. 13 is the simple Colpitts circuit, which differs from the Hartley only in having the cathode connected on the capacitance side instead of on the inductance side of the tuned circuit. "Clapp" is the tapped-down variety of Colpitts, corresponding to the Fig. 15(b) or (c) variety of Hartley. If a relatively small capacitance is tapped across one nth of a tuned circuit, either on the inductance or capacitance side, its effect is practically one (n^2)th of what it would be if tapped across the whole. Hence the benefit of tapping the maintaining valve across as small a fraction of the tuned circuit as will just do to maintain oscillation. In Fig. 16, for example, tapping 10pF across the whole tuned circuit adds 2% to the tuning capacitance and so alters the frequency by about 1%. Tapping it across one-tenth of the tuning reactance (5,000pF) alters the tuning capacitance by one hundredth of 2% and the frequency by only one hundredth of 1%, as you can check by calculation.

"REACTANCE SKETCHES"

Answer to "Cathode Ray's" Problem

This is the answer to last month's problem—to sketch the reactance curve of the circuit shown. Since C_1L_1' was made equal to $L_2'C_2$, both resonate as acceptors at the same frequency, f_{a2}. L_m resonates as a rejector with $L_2'C_2$ at f_r and as an acceptor with $L_1'C_1$ at f_{a1}. X_{m2} is the reactance of the $L_mL_2'C_2$ group, "translated" from the B curves in last month's Fig. 9 ; and X_1 is the reactance of C_1L_1' (or C_2L_2') alone, which added to X_{m2} gives the reactance of the whole circuit, X.



30 Years of Broadcast Engineering

Retirement of Sir Noel Ashbridge

WHICHEVER way one looks at it, control of the technical side of the B.B.C. is a big job—the biggest of its kind in the world, as the Corporation undoubtedly radiates more kilowatt-hours per day than any other broadcasting system. The job of Sir Noel Ashbridge, who has just retired from his post as Director of Technical Services of the B.B.C., has been truly a notable one. He has been concerned with broadcasting from the start, and for over a quarter of a century has held positions of high responsibility.

Sir Noel's entry into wireless was unspectacular; indeed, casual and haphazard. After taking his B.Sc. in engineering in 1911 he entered the "heavy" side of the industry, and showed little more interest in wireless communication than most other young engineers of the period. But, when he joined the infantry early in the 1914-1918 war, there was a call for volunteers who "knew something about wireless." Among those who took the traditional one pace forward was Private Ashbridge — a highly significant step, as it turned out.

At the end of the war Ashbridge returned to the heavy side of electrical engineering for a year before transferring in 1920 to Marconi's Wireless Telegraph Company, where he turned his wartime experience to account in designing field-station equipment. Shortly after joining Marconi's he moved to the experimental station at Writtle, then in charge of P. P. Eckersley, where, early in 1921, he made his first acquaintance with broadcasting during the weekly experimental transmissions from that station. Later jobs included receiver designing, including the earliest broadcast sets. When Eckersley left to become chief engineer of the British Broadcasting Company, Ashbridge was promoted to engineer-in-charge of the Writtle establishment, remaining there until he left to become Assistant Chief Engineer of the B.B.C. in 1926.

These were the great days of broadcast engineering, marked by the change from scattered 1kW transmitters to the Regional scheme that foreshadowed the present chain of high-power medium-wave stations. This was real engineering, and Ashbridge came into his own, first as assistant to Eckersley, who conceived the Regional idea, and then, three years later, as Chief Engineer of the Corporation. Decisions were made during this period that still affect the whole pattern of the B.B.C. Home and Overseas services. The honour of knighthood, conferred in 1935, came as a fitting tribute to the consolidation of the B.B.C.'s basic structure. But Sir Noel, though described by a senior member of his staff as "a pessimist, like all good engineers," never suffered from excessive conservatism, and was soon to make the difficult decisions leading to the establishment of the world's first public television service.

The rest of Sir Noel's career is fresh in the memory of most of us. Landmarks are his appointment as Deputy Director-General of the B.B.C. (1943-1947) and Director of Technical Services from 1948. He was elected President of the I.E.E. in 1941-2.

Just before Sir Noel left Broadcasting House, *Wireless World* tried to extract from him his views on the future of British broadcasting. We should have known better; he is, first and last, an engineer, and prophecy is none of his business. But he did commit himself to saying that for the B.B.C. even to maintain its present standards of coverage in the face of increasing interference the use of v.h.f. transmission is essential as a supplement to the present system. He believes the Wrotham a.m./f.m. experiment proves conclusively that frequency modulation is the right method for such a purpose.

Television is considered by Sir Noel as one of the greatest achievements of radio, and one guesses that this branch of broadcasting is very near to his heart. He believes this country has lost nothing by choosing the 405-line standards, and, on the next stage of development, thinks we shall have a colour system "compatible" with the present one, but that a *de luxe* colour service in parallel is not out of the question.

"Should a radio engineer be a physicist with a leaning towards engineering, or an engineer with a leaning towards physics?" Sir Noel refused to be drawn on this controversial point, and rightly points out that one of the things we have learned of recent years is team work. There is plenty to do for both engineers and physicists. On the training of engineers, he stresses the importance of early factory experience, and regards the present tendency towards specialization as more or less inevitable, but undesirable if allowed to go to extreme lengths.

One feels, with a touch of sadness, that Sir Noel's departure from Broadcasting House marks the end of an epoch. But ability to keep his feet on the ground is his outstanding characteristic, and he would certainly not subscribe to the idea that the present time marks any particular stage in broadcast development. Doubtless he would say the engineering side is still passing through a steady process of growth, and would never mention his own contributions. Our readers will join with us in wishing him all good fortune.

Two Marconi RB.109 Automatic Marine Beacons are being erected in South Georgia, primarily for the use of Antarctic whaling fleets. The stations are designed to operate without attention for three months at temperatures down to 12°F and wind velocities up to 120 m.p.h.

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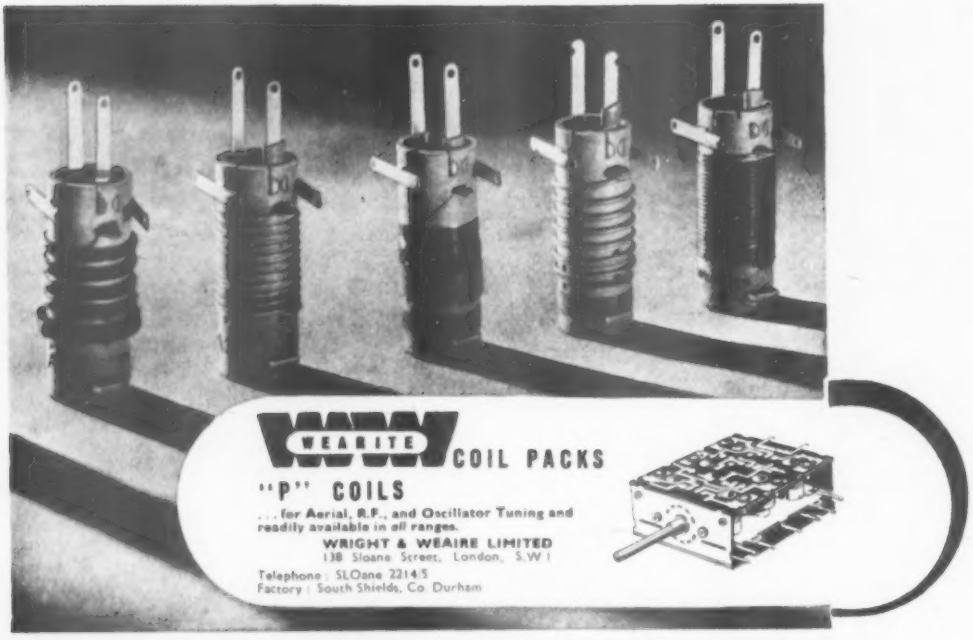
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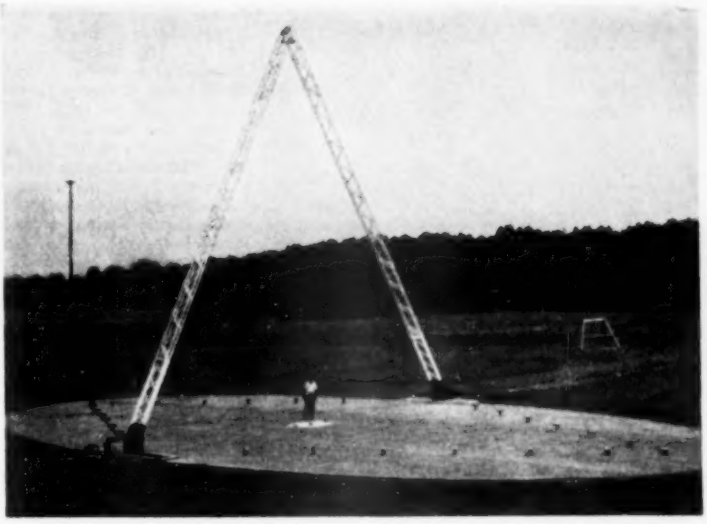
IC9

Testing Aerials

Actual Conditions Simulated by Scaled-Down Aerials and Centimetre Waves

By

MICHAEL LORANT



Full view of model aerial range with target transmitter raised to the 90-deg position.

THE U.S. National Bureau of Standards has recently completed a new model aerial range to facilitate the measurement of radiation patterns in the vertical plane. The range is believed to be the largest ever designed for this purpose and is composed of an inverted "V" type structure which supports a test or target transmitter more than 50 feet above a ground plane, in the centre of which is placed the scaled-down aerial to be tested. The model techniques employed in this type of installation are being applied to investigation of the behaviour of high-frequency aerial systems used in ionosphere-sounding equipment

The investigations are particularly concerned with the long range band from 3 to 30 Mc/s. At these frequencies the wavelength varies between roughly 300 and 30 ft; consequently measurements of full sized aerials would require a site several thousand feet long. This presents a problem when merely ground plane radiation patterns are desired; but, when the pattern in a vertical plane is required, the problem becomes even more complex. Some investigators have utilized free-flight balloons and aircraft to carry the test or target transmitter aloft, but the results have been only partially satisfactory. The new model range was set up to provide a more reliable means for such studies.

Principles of Operation

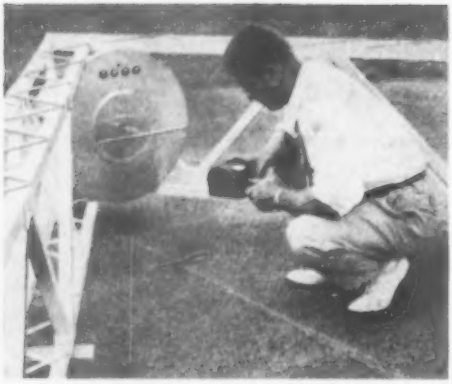
The model techniques employed are similar in many ways to those used in the investigation of mechanical, hydraulic, and aero-dynamic structures. The principle is known as electrodynamic similitude. As applied to an aerial, an equivalent performance is obtained from a model $\frac{1}{n}$ th as large as the original if its operating frequency is made n times the prototype frequency. As the model frequency is increased, the free-space wavelength is decreased proportionately, and the distance between the transmitting and the receiving aerials can then be reduced by the same scaling factor n. Thus it becomes possible, by using a sufficiently large scaling factor, to mount a target transmitter on a rigid structure, to move it over and about the model aerial under test, and to obtain radiation patterns substantially the same as the true long-distance radiation patterns of a full-scale aerial. The term "radiation pattern" is used here synonymously with the receiving pattern of the aerial.

The measurement of aerial radiation patterns are very complex, especially when the system is intended for long-distance operation. Several restrictive problems must be overcome before actual transmitting conditions can be simulated. For example, the wavefront intercepted by the aerial to be tested must be essentially plane, and the phase relationship of the voltages induced in it must appear as though the wave had originated at a distance large compared to the size of the aerial. Also, a separation of at least several wavelengths must exist between the target transmitter and the test aerial in order to minimize the surface wave component of the radiated fields.

Scaling Factor

In recognition of these restrictions, a scaling factor of 60 ($n=60$) is employed in many of the applications. Thus, a prototype frequency between 1 and 25 Mc/s is represented by model transmitter frequencies between 60 and 1,500 Mc/s. At these frequencies it is comparatively easy to arrange a model transmitting-receiving system so that it satisfies both of the previously mentioned limitations.

In addition to dividing the physical dimensions of the model by the scaling factor n, and multiplying the frequency by the same factor, it is necessary to multiply the conductivity of the aerial and the earth by n. Fortunately, in most practical h.f. aerials the copper losses are small, and the conductivity effects may be ignored without introducing any serious error. On the other hand, in considering earth conductivity certain factors must be recognized; in a given location the conductivity as well as the dielectric con-



Checking the operating frequency of a target transmitter. The working frequency is between 60 and 1,500 Mc/s.

Adjusting a model aerial on the testing range. The wire netting "earth" shows up well in this view.

stant of the earth varies with weather conditions, and the earth constant varies from one geographical location to another. Consequently, it becomes necessary to specify a "standard earth" for certain operating conditions. Ideally, if different values of scaling factor are to be used, the material forming the earth plane of the model range should be changed so that its conductivity would be that of the "standard earth" corresponding to the new scaling factor. One type of earth which does not require a scaling factor is a perfectly reflecting surface. Communication sites located on salt marshes and over sea water have practically this type of earth. For the purpose of the model range the problem was resolved by using an earth covering consisting of a small mesh wire netting, thus simulating a perfect earth.

The target transmitter is supported by two open-truss beams, each 60 ft in length, fastened together at one end to form a 60-deg angle. The other two ends of the beams are mounted to two horizontal colinear axes located just high enough above the ground to permit a 180-deg movement of the structure. In the vertical position, the structure resembles a giant inverted V. The structure is counter-weighted so that it requires very little power to move it through its path. The target transmitter is fitted into the vertex of the inverted V, and the model aerial is located at the centre of the earth plane.

The radio energy intercepted by the model aerial is rectified and the signal voltage is transmitted along underground cables to a recording pen attached to an automatic pattern plotter. Synchro-generators, connected to the axes of the V frame, transmit its position to the turntable of the pattern plotter. Thus an automatic record of the radiation pattern is plotted as a function of the angular displacement of the transmitter moving above the aerial. All the recording equipment is located in a shelter 200 ft from the aerial site.

A series of target transmitters which derive their operating power from small storage batteries within the unit are employed. This obviates the necessity of using connecting cables and wires which could reflect or otherwise disturb the radiated field. To prevent reflections that would be set up by a conducting material, the truss beams forming the V frame are made of non-conducting hard plywood. The frame, with the exception of the counter-weights, is comparatively light, and its maximum deflection due to its own weight is approximately 0.5 deg about the centre of the range.

NEWS FROM THE CLUBS

Birmingham.—Meetings of the Slade Radio Society are now held in the Church House, High Street, Erdington, on alternate Fridays at 7.45. On August 15th a d.f. test is planned with instruction for beginners. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Brighton.—The weekly meetings of the Brighton and District Radio Club during August will be informal and visitors to the town will be welcome. They are held on Tuesdays at 7.30 at the Eagle Inn, 125, Gloucester Road, Brighton. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton, 7.

Coventry.—The first of a series of talks on 144 Mc/s will be given by Ray Bastin at the meeting of the Coventry Amateur Radio Society on August 18th. It will deal with receivers. Meetings are held on alternate Mondays at 7.30 at the Y.W.C.A., Queen's Road. In order to foster members' interest in v.h.f. the chairman of the Club (F. Miles, G5ML) has presented a cup for competition. Sec.: K. G. Lines, 142, Shorncliffe Road, Coventry.

Manchester.—Meetings of the Manchester and District Radio Society are now held at the Brunswick Hotel, Piccadilly, at 7.30 on the first Monday of each month. Sec.: P. Dean, G3FNT, Fairfield, 31, Park Lane, Whitefield, Lancs.

Reading.—The programme arranged for the coming session by the Reading Radio Society includes lectures, demonstrations and contests covering v.h.f., tape recording, aerials and high-fidelity reproduction. Meetings are held regularly at the Abbey Gateway, Reading. Sec.: L. A. Hensford, G2BHS, 30, Boston Avenue, Reading, Berks.

Walsall.—As part of a recent carnival, organized on behalf of the British Limbless Ex-Service Men's Association, the Walsall and District Amateur Radio Society set up a transmitting station (G2FPR/A) and provided a display of radio gear. The station was on the air for 8½ hours on 160 metres. Sec.: F. J. Merriman, G2FPR, 123, Wolverhampton Road, Walsall.

Remote Control of Large Travelling Cranes

THERE are two quite distinct applications of radio to the control of large overhead travelling cranes; one is when the crane operator should be close to the load being handled in order to exercise precise control and the other when he should be, in the interest of personal safety, as far away as possible. The latter is obviously a rather necessary condition, for instance, when handling radio-active materials and certain poisonous substances.

Both these applications were demonstrated by the Vaughan Crane Company at the Mechanical Handling Exhibition and Convention organized by *Mechanical Handling*, and held in London in June. Radio equipment for remote control of the crane is made by Heenan and Froude and goes under the name "Vestrad."

Transmission and reception is effected on closed loops in order to limit the range, three carrier frequencies on 52, 56 and 61 Mc/s respectively being employed. One controls the travel of the crane along the gantry, another the transverse motion and the third the lifting mechanism. Audio modulation tones are used for movement in one direction or the other in each case, and the three carriers can be used simultaneously or separately.

Radio equipment fitted to the crane comprises a three-channel receiver, tuned relays and selectors to distribute the controlling tones to the electric motors of the crane.

There are safeguards against all contingencies and a radio failure in any channel brings the motion concerned to a halt, while limit switches prevent overrunning.

Rather less than 5 watts transmitting power is used for the control of loads up to 100 tons or more. The equipment is constructed for portability and easily carried by one man, the transmitters and control panel in a case slung on his chest and the loop aerials in another carried on his back.

For control at a distance, such as when handling the "dangerous" class of materials, a television camera and remote viewing screen are used. These enable the crane operator to "see" from a safe distance, or a secure place, the movements of the hoisting "grab" on the crane and the actual load it is required to move.

The camera is a standard Marconi Image Orthicon as used by the B.B.C. and also for underwater television. It is connected to the viewing screen by a multi-wire cable, instead of a radio link.

With the additional facility of television it will usually be more convenient to employ a fixed rather than a portable radio transmitter and this can be mains operated. Some modification in the aerial systems may be needed as the effective range of the small portable loops is limited to about 20 to 30ft outside the actual area of the gantry.

Television viewing screen and radio equipment used for remote control of the Vaughan crane.

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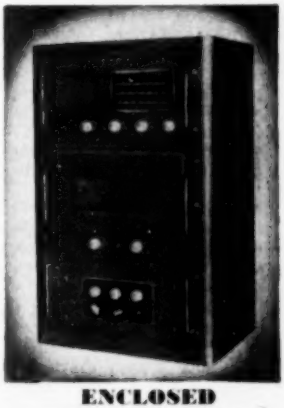

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By "DIALLIST"

A Useful Tool

WHEN I COME ACROSS something original and good in the tool line I make a point of passing on the results of my tests for the benefit of those readers who may be interested. It may be mentioned, in passing, that I try out a fairish number of new tools and workshop gadgets in the course of a year and that very few of them qualify for so much as a line of description. Here's one that definitely does. For some weeks now I have been using a Burgess Vibro-spray painting tool and I can't think of anything quicker, handier or more effective for painting and varnishing cabinets—or any of the jobs involving the application of a thin and even coating of material in a liquid state which come the way of the wireless man. The principle is most ingenious. A.C. from the mains is fed to the windings of an electro-magnet, provided with a laminated armature, free to move inwards and outwards, and working against a coiled spring. As current rises towards a peak, the armature overcomes the thrust of the spring and moves towards the magnet poles. When current is approaching zero value the spring asserts itself and pushes the armature away from them. Connect the armature to the piston of a small pump provided with ball-valves, and there you are. During the outward movement of the piston, paint is drawn up from a container through a feed tube. The inward movement of the piston forces the paint through a tiny nozzle arranged on the lines of the old fishtail gas-burner. The result is a narrow, flat "beam" of finely divided paint.

Colour-Coding Problem

A MANOR PARK, London, reader very kindly sends me a resistor which seems to prove my point that colour-coding is not always quick to read, or foolproof. This is a half-watt resistor with a greyish-white body. At one end are the following bands, reading inwards: brown, green, gold. "A number of servicemen and others," says my correspondent, "were asked to read the colour coding. In most cases the answer was a not very confident '15 ohms.'" He adds "I wonder if your answer would be the correct one." I'm ready to admit that it would not have been. When doing a good deal of constructional work one gets the code more or less into one's head. But it soon goes. To confirm my correspondent's figures I had to use a "crib" in the shape of the invaluable *W.W.* Diary. The brown band means 1 right enough and the green one 5; so far, then, we have 15. But what of the gold band? It indicates a decimal multiplier of 0.1; so 1.5 ohms is the correct answer. The resistor is one of ±20 per cent tolerance, as shown by the "no-colour" body. Would it not, though, be a quite understandable slip to read its markings as indicating a value of 15 ohms with a ±5 per cent tolerance? For gold also indicates a tolerance.

Spot-Wobble Again

I HAVE FOUND several eminent designers with whom I have discussed spot-wobble still inclined to fight shy of it: "Too risky in the hands of the man in the street. Might cause troubles worse than those it's meant to cure." For the life of me I cannot see why. There must, of course, be an on-off switch for the wobble and both serviceman and user must have it impressed on them that focusing must be done with the spot unwobbled. And, supposing that the user is odd enough to find that he prefers the presence of the lines to their absence, all that he has to do is to move the wobble switch to the off position—and keep it there. About spot elongation and other methods of deliberately introducing a certain amount of astigmatism, I'm not quite so sure. Certainly an on-off switch is equally necessary here, so that the user may see for himself just what the system does and may be able to put it out of use if he doesn't like the results.

Traps for the Unwary

INVALUABLE AS IT IS to the radio man and the television man, if properly used, the oscilloscope can furnish images full of pitfalls for those who do not look before they leap; or, in other words, those who base their readings on a hasty appreciation of the "obvious" indications. Here is a case in point that I came across recently. The output of a diode detector was being tested by means of the Lissajous-Figure method. The hook-up was this: an r.f. oscillator was used to modulate an h.f. oscillator, the modulated output being fed via a pentode amplifier to the diode. The output of the diode was fed to the Y_1 plate of the tube. The a.f. signal was passed to X_1 by way of an amplifier. Y_2 and X_2 were earthed. The difference in the X and Y sensitivities was balanced out approximately by suitably adjusting the X amplifier. Thus, with no phase difference between the X and Y voltages, the image would have been a straight line, lying (with these connections) at about 135 deg.

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The detector was, actually, a rather poor one and the image proved to be a deformed ellipse with its major axis at roughly 135 deg. The upper and lower ends were distinctly pointed and the trace was not "clean"; the envelope for some distance above and below the middle of the major axis was "muzzy." The bright youngster who was operating the oscilloscope gave his reading without hesitation: Linearity poor; considerable phase-difference; h.f. leakage through the detector. An old hand spent rather more time in examining the screen. "Take another look," he said, "and see if you are sure about that h.f. leakage." "Why, yes," said the young fellow after another glance. "Surely, it's obvious. Look at those muzzy bits." If you are an oscilloscopist, draw the hook-up I've described and, also, the pseudo-ellipse showing the vague, broadened trace in the parts I've mentioned. Done that? Good! Well, who was right? The output of the detector was connected to Y_1; hence, had there been h.f. leakage, the broadening of the trace would have been in a vertical direction: it would have affected, that is, the parts of the envelope that are most nearly horizontal—small sections near the pointed ends. Actually, the muzziness is seen to be in the most nearly *vertical* parts of the envelope and it can be due only to horizontal deflections of the spot, produced by the X-plate voltage. Hence it indicates h.f. in the X-plate supply and must be due either to pick-up by the wiring or to oscillation in the X-amplifier.

Vive La Télévision!

MONSIEUR SALLEBERT, the London representative of Radiodiffusion et Télévision Françaises gave a most successful cocktail party a few days before the opening of the Franco-British television relays. One excellent point that he made in his speech of welcome was that throughout the development work done by B.B.C. and R.T.F. engineers prior to the broadcast, there was not the smallest hint or thought of rivalry. The keyword was co-operation. Neither side made any effort to plug the superiority of its own system. What both wanted was a practical means of converting French 819-line television to British 405-line standards and vice-versa. That had been developed and there was now no practical obstacle to programme exchanges between countries using widely different definition standards, provided that the necessary co-axial cables or radio links were available.

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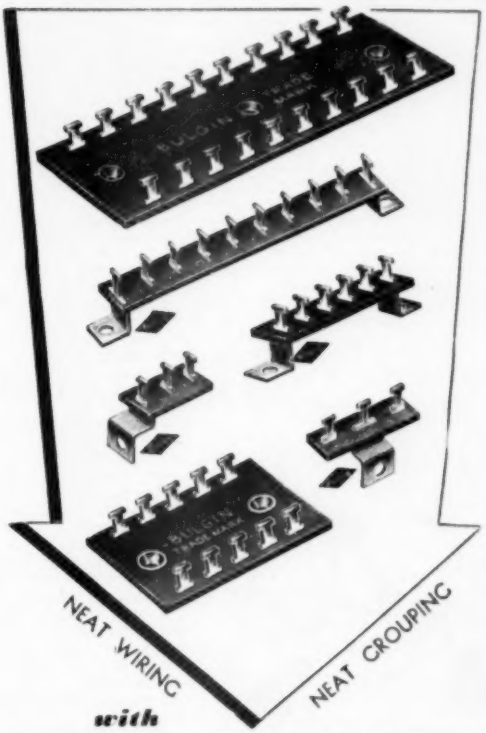

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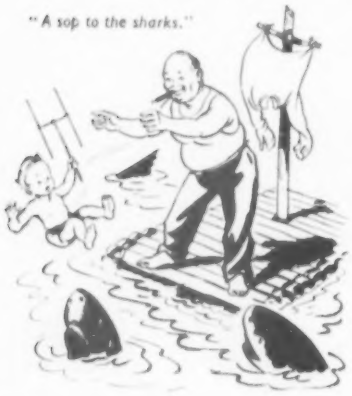
By FREE GRID

A Television Munich

IT has been said that a potted history of these islands could be written merely quoting the popular catchwords and phrases that have been in vogue from time to time. Thus in 1752 it was "Give us back our eleven days," in 1911 it was "9d for 4d" and in 1938 it was "appeasement." At the present moment it is undoubtedly "sponsoring" or, more fully, "sponsored television." Some people, notably Lord Reith, profess to see a strange similarity between the catchwords of 1938 and 1952.

However, it is no business of mine,



"A sop to the sharks."

writing in a technical journal like *Wireless World*, to debate, like the architect of the B.B.C.'s great prestige, whether or not some sinister hidden hand is compelling Mr. Churchill to throw television overboard as a sop to the sharks as some say Mr. Chamberlain had to do with Czechoslovakia at Munich.

But, if political considerations are no concern of mine, it certainly is my business to deal with the technical tangles involved in this matter and to point out the perilous paths on which television might be forced to take in order to unravel them.

I feel, however, that before dealing with these technical pitfalls, I ought to confess that, having had some experience of the nightmare conditions prevailing in the world of U.S. "telecasting," to say nothing of the babbling Bedlam of American sound broadcasting, I am prejudiced against sponsored programmes in any shape or form and should be so even were there no grave technical objections. Dante's Inferno "pictorialized specially for television by the Fyrene Co." would just leave me cold. I would far rather watch an indifferent broadcast of "The Tempest" by the B.B.C. than a first-rate one paid for by an umbrella manufacturer.

At the present moment we have a very good television service which gives us the highest definition we can at present afford, both in terms of money and of etheric elbow room, but there are certainly no channels to spare. Now, there is one way of getting more etheric elbow room and that is by using much higher frequencies than we do at present, and it might seem, on superficial examination, that here lies the solution for the B.B.C. and S.T.V. (Sponsored Television) to exist side by side. But in a few years' time, with the coming of colour and other technical improvements, the B.B.C. television service will want all the extra elbow room it can obtain by the use of higher frequencies and there will still be none to spare for S.T.V.

The only way to get sufficient etheric room for both B.B.C. and S.T.V. when both are using colour, and other developments which can already be foreseen, would be to use extra-high frequencies indeed. Now apart from the fact that, owing to the restricted range of e.h.f. television, a very large number of stations would be required to give nation-wide coverage, receiver design would become very involved and maintenance very costly for, in addition to the complications of design which extra-high-frequency television would bring *per se*, there would have to be switching or tuning arrangements so that viewers could change from one service to another.

The sets would, in fact, be too complicated to be placed in the hands of the ordinary public, and a state of affairs would arise where everybody depends for their television and, eventually, their sound broadcasting too, on a wired relay service. It has been pointed out time and again in this journal what a bad thing it would be if wired wireless became universal and I am not going to dwell on it again here as it is a political matter and not a technical question.

The Scopetron

CAN anybody suggest a more suitable name for the heart and soul of our television sets and oscilloscopes than cathode-ray tube? The abbreviation c.r.t. is altogether lacking in dignity and makes it unable to hold its head up among its fellow thermionic tubes.

The name must describe the tube's function and it must end in "tron," but please don't suggest the obvious, but meaningless, "cathotron" to me. Since the tube enables us to examine a lot of things, ranging from a football match to our heartbeats, I would suggest "scopetron" (three syllables, please) which means a device whereby we can make an examination. Can you do better?

Electronicitis

WORDS which are *over*-used, as so many of them are nowadays, tend to become *mis*-used. Women in particular seem to take a delight in using a favourite word whenever they can squeeze it into a sentence. They mangle its meaning with as much zest as they endeavour to mutate their faces into something rich and rare. Concerning these facial mutations—or should it be mutilations?—Gilbert tells us that:

> "Little dabs of powder
> Little dabs of paint,
> Make a woman's features
> Look like what they ain't."

But no bard has yet sung of the far more serious mutations of meaning which women inflict on words. Some of the B.B.C.'s female announcers, with their eternal and infernal misuse of the word "nostalgic" are among the chief offenders.

I am sorry to say, however, that this wretched habit of treating a new word like a new toy has spread to the radio and electrical industries where "electronic" has become a fetish word which must be worked in at all costs no matter whether it be redundant or not. At a recent industrial exhibition I was invited to inspect a piece of apparatus which was, in fact, a simple three-valve a.f. amplifier and nothing more, but was it so described? Not on your life! It had become an *electronic* amplifier and it employed nothing so old-fashioned as thermionic valves but *electronic* ones. It is true that both were indeed electronic devices but not more so than were the ones we used a generation ago.

I rather wonder why nobody has yet thought of founding an Institution of Electronic Engineers; on second thoughts I think I will do it myself, as I should rather fancy writing M.I.Etron.E. after my name.

"Rich and rare."

A RADICALLY NEW PRE-AMPLIFIER FOR LEAK 'POINT-ONE' POWER AMPLIFIERS

The

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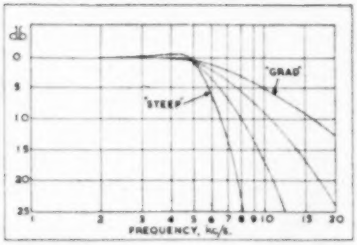

Frequency/amplitude curves for the "TREBLE—3" position (5 kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7 kc/s and 9 kc/s ("—2" and "—1" positions).

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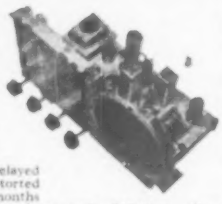

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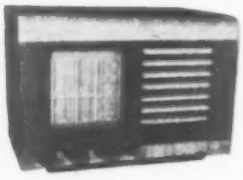

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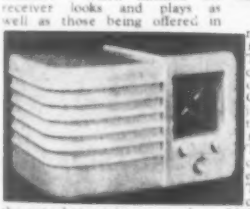

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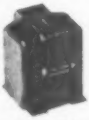

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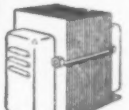

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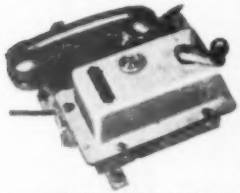
"SNIPERSCOPE"

Famous wartime "cats eye" used in conjunction with a lens system and h.t. for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work: burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments, price 9/6 each, or six for 52/6. Data will be supplied with cells if requested.



EX-ROYAL NAVY SOUND POWERED TELEPHONE

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several 'phones are used together will indicate which one is being called. Size 7¼in. × 9in. × 7¼in., wall mounting, designed for ships' use, but equally suitable for home office, warehouse, factory, garage, etc. Price 37/6 each, plus 3/6 carriage.

OCTOPUS CLIPS

An ideal clip for fixing anything to a rod or pole, this is self adjusting from 1¼in. to 4¼in. Price 1/- each.

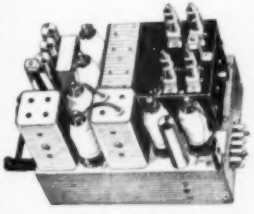
MAGNETIC TAPE RECORDER. YOURS FOR £10/10/-.

Tape Deck. Fitted with 3 motors giving fast rewind forward run and no friction. High fidelity record play back giving approximately 1 hour playing from standard 1,200ft. tape. Additional reels of tape 3/- each.
Amplifier. High gain enables recording to be made from microphone, pick-up or loud speaker. Separate bass and treble lift controls.
Cabinet. Portable, in rexine covered; table model is polished walnut.
Instruction Booklet. Shows in close detail exactly how to assemble and operate the recorder, is free with kit or available separately at 2/6. (Credited if you buy kit or completed recorder).
Price. Complete kit of parts including 6 valves, reel of tape, loudspeaker and cabinet (state whether portable or table model required), £31 or £10/10/- deposit and balance over 12 months. If required we will assemble and test for £4 extra. Suitable for crystal hand/table microphone £1/15/- extra.

THIS MONTHS SNIP

This month's snip is something for which many have waited a long time, further being a cancelled export order we can offer it at a special price due to saving of Purchase tax. Of course only a limited quantity is available so if you want one act quickly.
We offer the famous Garrard Auto Radiogram unit, RC72, universally agreed to be the world's finest. It is a 3 speed model which in addition to the usual refinements has two GP19 precision pick-ups (with two adaptors to facilitate easy changing).
Special Snip Price £16/5/- complete, or if you do not want to lay out this all at once send a deposit of £5/8/6. Non callers add 7/6 for carriage and insurance.

RECEIVER TYPE 25/73



Receiver portion of the TR.1196, undoubtedly one of the most useful little receivers that has ever been offered from Government Surplus Stores, because once the existing tuning unit is removed a standard coil pack can be fitted which makes a very efficient superhet at a very small figure. Alternatively for breaking up there is a pair of standard 465 kc/s dust cored IF transformers which would cost 12/6-15/-, and dozens of other items, tuning condensers, coils, preset condensers, pot meters, etc., etc. The price is only 9/6 plus 1/6 post and packing less valves, or 27/6 plus 2/6 post, packing and insurance with valves. The valves are as follows: 2 VR.53, 2 VR.56, 1 VR.57, and 1 VR.55.

Orders by post are dealt with by our Ruislip depot. To avoid delay address to Electronic Precision Equipment, Ltd. Dept. 2 Windmill Hill, Ruislip, Middlesex.

ADJUSTABLE THERMOSTATS

All thermostats are fitted with heavy silver contacts and can be adjusted to operate between 90° and 300°F suitable for use with aquariums, electric blankets, space heaters, greenhouse heaters etc., etc.
A.C. rating 1 amp 250 v. 3/6
A.C. rating 2 amp 250 v. 5/6
A.C. rating 5 amp 250 v. 14/6
Note. The two amp model is fitted with patent device which gives it a quick make and break action.

SPEMET

Made from polished aluminium, an excellent material for fronts of cabinets or for special cabinets you are making, and for air conditioners, etc.
Close mesh 8 holes to the inch, 24in. × 12in., 10/-, 12in. × 12in., 5/3, 6in. × 6in., 1/9.
Wide mesh 4 holes to the inch, 24in. × 12in., 9/-, 12in. × 12in., 4/9, 6in. × 6in., 1/6.
Postage and special packing 1/6 extra for any quantity up to 12 sheets. Over 12 sheets post free.

FERRANTI ELECTRIC METER MOVEMENT

A complete check meter except for case, brand new and unused. Has many uses, one for instance is that of telling the numbers of hours a piece of apparatus has worked. Price is only 17/6, post etc., 2/-.

FLEXIBLE COUPLINGS

These are sometimes known as bellows couplings because they will extend as well as bend. They are ideal for joining shafts which are out of alignment and for slug tuning controls where the core has to come in and out. Price 1/9 each.

SLIDER RESISTORS

Heavy Duty Type.
Size 7in. × 1¼in. 11 ohms 4.5 amp 22/-; Size 9in. × 1¼in. 1.2 ohms 15 amp. 15/-
Size 13¼in. × 1¼in. 3 ohms 10 amp. 15/-.

Except for heavy and delicate items where carriage charge is specified, orders over £2 are post free. Under £2 add reasonable amount, bearing in mind a 15lb. parcel costs 2/-. Postable items can be sent C.O.D., additional charge 2/6. List 6d.
Early closing days—Wednesday Ruislip, Saturday City.

ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780
152-153 FLEET STREET, E.C.4. Phone: CENTRAL 2833

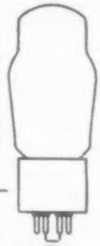
ELPREQ PAGES

10,000 VALVES AT PRE-BUDGET PRICES

Below is a list of B.V.A. and Other Proprietary Valves which we can supply at the pre-1951 Budget price i.e. only one-third Tax.

We can of course supply most of the other types to complete the range but those not listed would have to be charged at the current rate of Tax i.e. 66%.

We can give a very prompt insured C.O.D. service on valves and we shall be happy to execute your orders.



TYPES

0Z4
01307M
1A4E
1A4
1A5GT
1A5GT/G
1A6
1A7
1A6E
1BC1
1B4
1B4E
1B5/25S
1B7G
1B42
1B123
1C1
1C5
1C6
1C7G
1D5
1D5G
1D6
1D7G
1D8
1FD9
1FW4A
1F2
1F3
1F5G
1F6
1F7GH
1G4G
1G6G
1H4G
1H5G
1J6
1LA4E
1LC6
1LN5
1N5
1P10
1P11
1Q5GT
1RF120
1R5
1S4
1S5
1U5
1T5GT
1V
2
2A3
2A5
2A6
2A7
2A8
2D2
2D4A
2D4B
2D13
2D13C
2D17
2P
2YR215
2Z2
3Q4
3Q5
3Q5GT
3V4
3Y4
3A4
4D1
4THA
4TPB
4TSA
4TSP
4XP
4/100/BU
5U4G
5V4
5X4G
5Y3G
5Y4
5Y3S
5Z3
5Z4
6AB7
6AC7
6AE5
6AE6
6AF6
6AG6
6AK5
6AL5
6AM6

6AT6
6A3
6A4
6A6
6A7
6A8EG
6A8G
6A8GT
6BA6
6BE6
6B4G
6B6
6B7
6B7G
6B7M
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6B8G
6C4
6C5
6C7
6C8G
6C9
6C10
6D1
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6D6
6F1
6F6G
6F6
6F7
6F7E
6F8
6F13
6F14
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6F16
6F33
6G5G
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6H6
6H6G
6H7G
6H8G
6J5GT
6J5G
6J7G
6J8G
6K5G
6K8G
6K6GT
6K7GT
6K7G
6K8
6LD20
6LFG
6L5
6L5G
6L6GA
6L6G
6L7G
6L18
6L19
6N6GT
6N6G
6N7
6P5GT
6P8
6P28
6Q7GT
6R7GT
6SA7GT
6SA7G
6SF5
6SF7
6SG7
6SH7
6SJ7
6SK7
6SL7
6SN7
6SQ7
6SS7
6S7G
6T7G
6U5G
6U7G
6V6
6V7
6W5G
6W7
6X5
6Y4
6ZY5
6Z5
7A2
7A3
7A7E
7A8
7B5

7B6
7B7
7B8
7C5
7C7
7D3
7D5
7D6
7H7
7K7
7Q7
7R7
7S7
7Y4
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9D2
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10D2
10F1
10F3
10F9
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10P14
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12A6
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12Q7
12SA7
12SF5
12SJ7
12SK7GT
12SK7
12SH7
12SQ7
12SR7
13SPA
13PGA
13VPA
14A7
15
15A2
15D1
15D2
15E
17
18
19
20C
20D1
20D2
20F2
20P1
21A
22H41
24
24A
24E
24G
25A6
25A7
25B5
25D8
25L6GT
25Y5
25Z5
26
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27SU
28D7
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32E
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34
34E
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35A5
35L6GT
35Z3
35Z4
35Z5GT
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36E
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38

35E
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39/44
40SUA
41
41MDG
41MH
41MHL
41MLF
41MP
41MPG
41MPT
41MRC
41MSG
41MTA
41MTL
41MTS
41MXP
41STH
42
42A
42E
42MPT
42PTB
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43IU
44E
45
45IU
45Z5
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49A
50L6
50Y6
53KU
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56
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58
59
61BT
61SPT
62BT
62DDT
62TH
62VP
66KU
67PT
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71A
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75A
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101
104V
105G5
110
112A
117L7
117N7
117Z6GT
120
124
150
150A
150B
154V
164V
185BT
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202MPG
202STH
202VP
202VPB
203THA
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210DG
210HF
210HL
210LF
210RC
210VPT
215P
215SG
220B
220IPT
220P
220PA
220PT
220TH
220VPB
220VS

220VSG
22JH
224
225DU
230PEN
230XP
240QP
244V
290L4
301
302
302THA
303
307A
329
346
354V
410HF
410PT
415PO
415XP
422PT
424
425P
425XP
442BU
484V
523
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640G
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802
807
954V
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1215GT
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9006
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ACME
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AC PEN
ACPT PEN
ACP1
ACSG
ACTH1
ACTP
ACTZ
ACVH
AC VHPZ
AC VP1
AC2 HL
AC2PEN
AC2PENDD
AC4 PEN
AC5PENDD
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APP4AS
APP4C
APP4E
APP6E
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A20B
A27D
A30C

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A50B
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BVA43
BVA44
BVA45
BVA47
BVA48
BVA56
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CY32
C1C
C1
C2
C5B
C9
C10
C10B
C20C
C23B
C30B
C36A
C36C
C50B
C50N
DAC1
DAC32
DAF91
DC HL
DCP
DC2G
DC2GVM
DC2PEN
DC3HL
DDA13
DD14
DDPEN
DDTR13
DDT2
DDT4
DDT13S
DDT16
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DD4D
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DD101
DD207
DD620
DD2530
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DET19
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DF92
DF606
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DH24
DH63
DH73
DH76
DH77
DH101
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DH149
DH150
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DL510
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DL74M
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DL93
DL94
DL145
DN41
DN143
DN406

DV5G
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HD14
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HL21DD
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HL23
HL23DD
HL41
HL41DD
HL42DD
HL45DD
HL73C
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HL133DD
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HP211
HP211C
HP215
HP4100
HP4101
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HP4106G
HP4108
HP4115
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HR26
HR210
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HVR2A
HVU1
HW20L
H2
H2MB
H4D
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H20
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H141D
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IRV120/3505
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KK32
KLL32
KL4
KL32
KL35
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KTW61M
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K30G
K30K
K33A

K33B
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K50M
K50N
K52
K70B
K70D
K80A
K163
K404
LB210
LD2
LD210
LG210
LL4
LP2
LP220
L1
L2
L2DD
L13
L21DD
L38
L63
L77
L410
ME2
ME41
ME920
MHD4
MHL4
MHL13
MH4
MH41
MH206
MH4013
MH4105
MH4106
MKT4
ML4
ML6
MP/PEN
MR1
MS/PEN
MS/PENB
MSP4
MSP41
MS4B
MU4105
MVSPEN
MVSPENB
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N78
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N145
N147
N148
N150
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OD3
OM1
OM4
OM5
OM6
OM9
OM10
O202
PA1
PA20
PD220
PD220A
PD3521
PENB4
PENDD/1360
PENDD/2530
PENDD/4020
PEN4A
PEN4DD
PEN4VA
PEN23
PEN24
PEN25
PEN30C
PEN36C
PEN40DD
PEN44
PEN45

PEN45DD
PEN46
PEN220
PEN220A
PEN231
PEN383
PEN428
PEN453DD
PEN3520
PJ10
PL33
PL38
PL38M
PL82
PM2
PM2A
PM2B
PM2HL
PM3
PM12
PM12M
PM14
PM20
PM22
PM22D
PM24A
PM24M
PM25
PM202
PM252
PP14
PP2
PP3/250
PP3/425
PP5/400
PP6B
PP6C
PP6E
PP13A
PP24
PP246
PP35
PP225
PP411C
PP4118
PP2018
PT/DD85DA
PT4D
PT10
PT24A
PT24DAL
PT41
PT230
PV20
PV495
PX25
PX230
PX230SW
PY30
PY31
PY80
PY82
P2
P61
P14ON
P215
P220
P220A
P425
P430
P610
QP21
QP22B
QP25
QP42
QP230
RB41
RB120
RC250/1000
RF120
RV12P2000
RX210
R2
R3
R10
R12
R16
R42
SD6
SD20
SE211
SE211C
SG220
SG220SW
SG410
SPT4A
SP2
SP2D
SP4
SP4B
SP13

SP13C
SP135
SP20
SP22
SP41
SP42
SP45P
SP61
SP141
SP181
SP210
SP215
SP220
SP1320
SP2220
SQT4
SS210
SU25
SU61
SU21500
SW1
S3DD
S4A
S4V
S4VA
S6
S23
S130
S215VM
S217
S410
S410N
S435N
S1328
TBC14
TBL14
TBL44
TB062
TB162
TB122
TB622
TB5013
TB2520
TCH24
TDD2A
TDD4
TDD13
TDD13C
TDD25
TE504
TF44
TH2
TH4B
TH13C
TH21C
TH29DA
TH30
TH30C
TH41
TH233
TH2321
TM1
TM14
TP22
TP23
TP25
TP26
TP220
TP230
TP1340
TP2620
TSP4
TT4
TT4A
TX4
TX21
T2
T20
T31
T32
T41
UAF41
UAF42
UBC41
UBF80
UBL21
UB41
UCH21
UCH42
UD41
UFW20L
UF41
UF42
UL41
UL44
UL46
UM34
UNI-BALLAST
URIC
UR2

UR3
UR3C
UR13
UU3
UU7
UU9
UU30/250
UU41
UU60/250
UX6
UY1N
UY21
UY41
U4
U10
U17
U18/20
U31
U24
U25
U30
U33
U35
U37
U71
U74
U76
U78
U81
U82
U101
U142
U145
U147
U149
U150
U201
U404
U801
U914
U920
VMP4G
VM4K
VO28
VO48
VO13
VO135
VPT4
VP2
VP2B
VP2D
VP4
VP4A
VP4C
VP13
VP13A
VP13B
VP13C
VP13K
VP13X
VP14
VP20
VP23
VP28
VP41
VP41E
VP60
VP133
VP210
VP210DD
VP1320
VP1322
VR1C
VR43
VR135
VR130
V312
V872
V914
V960
V1907
V30
V5116
VW48
WD40
WD142
W17
W21
W42
W76
W77
W81M
W142
W143
W145
W147
W148
W150

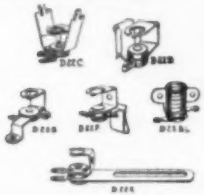
SUNDRIES

INDICATOR LAMP

This is fitted with a clear Perspex top, it is therefore highly suitable as an indicator lamp or for illuminating inside a radiogram or similar cabinet or even as a map reading light in a car. Takes standard screw-in flash light bulb. Price 1/6 complete.

LAMP HOLDERS

We carry a large assortment of dial lamp holders. Price **6d.** each. Order by list numbers.

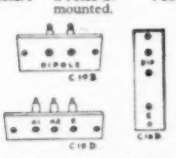


2-PIN PLUG (C20B) Split Pin type, fits most of our sockets, C16A, C16B, etc., **6d.** each.

SPECIAL SWITCHED PANEL (C16A)

This is a 2-socket panel with optional switching for internal and external L.S. Just inserting two pin plug, C20B gives both speakers, pushing it right home cuts out internal speaker. Price **9d.** each.

SOCKET STRIPS. Paxolin mounted.



Two socket engraved L.S. **6d.** each. Bin. C16B.
Two socket engraved A.E. **6d.** each. Bin. C18A.
Two socket engraved P.U. **6d.** each. Bin. C19B.
Two socket engraved Dipole **6d.** each. Bin. C19B.
Two socket plain. **5d.** each. Bin. C18B.,
Three socket engraved DIP and E. **9d.** each. Bin. C16D.
Three socket engraved A1, A2 and E. **9d.** each. Bin. C19D.
Four socket engraved A.E. Pickup, **9d.** each. Bin. C19E.
Four socket engraved P.U. Ext. L.S. **9d.** each. Bin. C16E.
Five socket plain. **9d.** each. Bin. C16C.

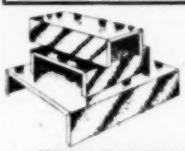
£5 FREE! SOMEBODY MUST WIN — WHY NOT YOU?

During my radio repairing days, I had many cases of sets failing for silly reasons, such as not being switched on or the shilling having run out, but one which particularly stands out in my memory concerned an old Lissen receiver.
The owner said it played O.K. but could only receive one station. Sure enough I found that no matter to where I turned the pointer, the Light Programme (it was called the Forces at the time) kept steadily playing. I cannot remember just how long it took me to find the trouble but it was long enough to cause me to say some unprintable words when I did.

What was wrong?

Prizes of **£5, £3,** and **£2** will be sent to the first three correct answers opened.

Notes: 1. The correct answer and the names of the winners will be sent to all entrants.
2. Entry should be on a separate sheet, but it can be sent in the same envelope as your order or correspondence.
3. Entries must be in by first post August 30th.



BLANK CHASSIS
18 S.W.G. Aluminium

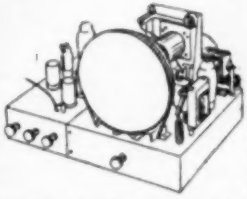
7 × 3½ × 2 ..	5/-	16 × 10 × 3 ..	8/3
9½ × 4½ × 2½	5/9	16 × 8 × 3 ..	8/-
10 × 8 × 2½ ..	7/-	11¼ × 10 × 3	7/6
10 × 5½ × 2½	6/6	16 × 12 × 3 ..	8/8
10 × 9 × 3 ..	7/3	19½ × 9 × 2½	8/3
12 × 9 × 2½ ..	7/3	20 × 10 × 3 ..	10/-
14 × 9 × 2½ ..	7/6	21½ × 9½ × 2½	10/6
14 × 10 × 3 ..	8/-		

TELEVISION For PLEASURE & PROFIT

TWO RECEIVERS AVAILABLE IN KIT FORM FOR SMALL OUTLAY

We offer Hire Purchase terms on two alternative sets:—

P.T. ARGUS. This was described in three recent issues of *Practical Television* and we have had good reports about the quality of reception. This Televisor uses the Government surplus tube Type VCR97 which is now firmly established in the domestic T.V. field. The total price of all components and tube is approximately **£20** (list on request) or if you prefer send only **£7 deposit** the balance can be spread over 12 months.



VIEWMASTER. This set we need not describe, the name being almost a household word, the total cost depends largely on the type of tube used and as from time to time we have perfect tubes to offer at half current price due to the fact that they have had slight use, we suggest that you leave purchase of the tube until last.

The total cost of the Viewmaster is approximatley **£35** plus the tube, but you only need send **£12** deposit, the balance can be spread over 12 months.

If you would rather study the data then send 2/6 for P.T. Argus of 7/6 for Viewmaster, we are quite willing to refund your cash if you return the data within 7 days.

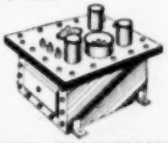
T.V. CABINET

This is a very handsome walnut finished cabinet ideal for Viewmaster or practically any other T.V. using up to a 12in. tube. A platform is fitted but it is a small matter to alter the position to suit your own chassis. Baffle board for 10in. loudspeaker is also included as is a hardboard back. Internal dimensions 2ft. 7in. high × 1ft. 4in. wide × 1ft 8in. deep. Price **£9/9/-**, carriage and packing 10/- extra.

Orders by post are dealt with by our Ruislip depot. To avoid delay address to Electronic Precision Equipment, Ltd., Dept. 2, Windmill Hill, Ruislip, Middlesex.

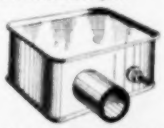
METAL RECTIFIERS

The one illustrated is a special bargain being available at considerably below cost. It is a selenium type rectifier rated at 12 v. 2½ amps., it is of course a full wave type highly suitable for battery chargers. Limited quantity Price 17/6 each.
Also available 6 v. 1 amp Type Price 5/- each. 12 v. 1 amp Type Price 9/- each.



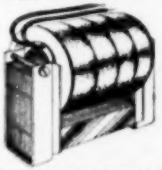
RADAR TRANSFORMER

For pulse work at 4 kV., this is Ministry style No. 224261 Type 2. Oil filled and fitted with two valve holders and ceramic insulators. It contains a pulse transformer, a choke and a filament transformer, all of which are designed to operate on 4 kV. Price on request.



INDUCTANCE CONDENSER UNIT TYPE 21

Intended to operate with the above pulse transformer Ministry No. 10C/11335. This again is made for 4 kV. work.



HIGH VOLTAGE ISOLATION TRANSFORMER

Ratio 1 to 1 made for voltages up to 4 kV. but probably would be safe on even higher voltages.

PLASTIC EYE SHIELDS

Ideal for hundreds of jobs such as C.R. Tube testing, motor cycling, paint spraying, etc. The illustration shows them being used to keep soap out of the eyes during hair washing. Price 6 pairs for 1/-.

Except for heavy and delicate items where carriage charge is specified, orders of over £2 are post free. Under £2 add reasonable amount, bearing in mind a 15lb. parcel cost 2/-. Postable items can be sent C.O.D. additional charge 2/6. List 6d.

EARLY CLOSING DAYS WEDNESDAY, RUISLIP—SATURDAY, CITY.

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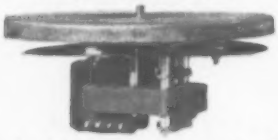
WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780
152-153 FLEET STREET, E.C.4. Phone: CENTRAL 2833

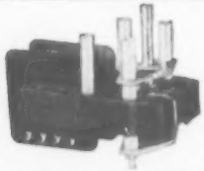
CLYDESDALE

Bargains in Ex-Service Radio and Electronic Equipment

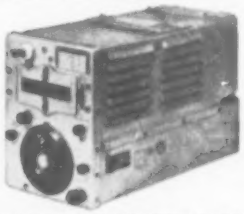
A.C. MAINS 200 250 Volts GRAMOPHONE MOTORS



Fitted with 9in. Turntable and mounted on 8in. metal plate, for crystal pick-up. Mfg. special line.
Clydesdale's Price Only **58 6** Each Post Paid

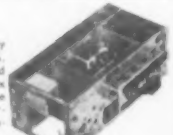


A.C. MAINS INDUCTION MOTOR
for 100-120 or 200-240 volts. Ideal for models, recorders, etc. ¼ hole fixing (with fixing screws). Spindle dia. ¼in. length 1¼in. Speed 1,500 r.p.m.
Clydesdale's Price Only **27 6** Each Post Paid



COMMAND TRANSMITTER CHASSIS
Partly stripped by the M.O.S., less valves, coil windings, crystal and dynamotor, but otherwise fairly intact. A fine basis for ideas in V.F.O. or Tx.
Original valve types 2-1625, 1626, 1629.
Conversion suggestions and circuits supplied in aluminium case. Dim.: 7½ x 5 x 8in. Weight 8½lb.
Clydesdale's Price Only **15/-** Post Paid

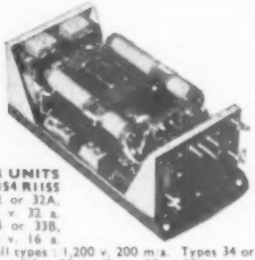
BC625-A TRANSMITTER CHASSIS
Less valves, and partly stripped by the M.O.S., R.F. section in good order. Dim.: 15½ x 7½ x 6in. Separate Modulation Transformer and Choke supplied.
Clydesdale's Price Only **29 6**



Carriage Paid.

PRISMATIC COMPASS
Hand Compass type 06-A Ex R.A.F. hand compass fitted with sighting prism, enabling a viewed object to be sighted and the bearing read simultaneously. The Cardinal disc, marked in degrees 0-360 can be illuminated for use at night by means of dry batteries fitted into the handle and controlled by a press switch. Size 4¼in. dia., L. overall 9in., in transit case.
Clydesdale's Price Only **£3 15 0** Carriage Paid.

TRANSMITTER UNIT T.1154
A 3-range 10-5.5 Mc/s., 5.5-3 Mc/s., 500-200 kc/s., 4-valve 2 PT15, 2 ML6. Transmitter Unit, in metal case. Dim.: 14 x 16½ x 8½in. Power requirements (external) H.T. 1,200 v. D.C., 200 m.a. L.T. 6.3 v. 4 a. 6 v. 2.5 a.
Clydesdale's Price Only **£12 12 0** Carriage Paid

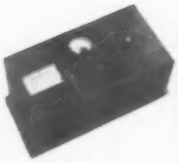


POWER UNITS for T1154 R1155
Types 32 or 32A, input 12 v. 32 a.
Types 33 or 33B, input 24 v. 16 a.
Output all types: 1,200 v. 200 m.a. Types 34 or 34A: input 9.3 v. 23 a. Types 35 or 35A: input 18 v. 12 a. Outputs all types: L.T. 7.2 v. 13 a.; H.T. 225 v. 110 m.a. Types 32, 33B and 35A in original cartons.
Clydesdale's Price Only **63/-** Per Unit, Carr. Paid
All other types, open stored, **42 6** per unit, carr. paid.

NEW LIST NO. 8C
Giving details and illustrations of ex-services items and cancelling all previous lists and supplements.
Now Ready—Price **1/6**.
Price credited on first purchase of **10/-** or over.

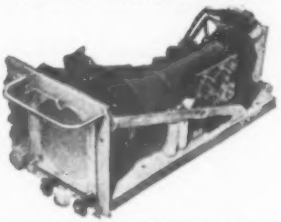
F24 AIRCRAFT CAMERA, complete with lens and suitable for hand or electric use. Takes 5in. width film, picture size 5½ x 5in. A precision air survey camera. Could be used for laboratory, industrial or portraiture. Focal plane shutter, 12 or 24 volt.

With f.2.9-8in. lens.
Clydesdale's Price Only **£9 19 6** each
With f.4.-5in. lens.
Clydesdale's Price Only **£7 19 6** each.
In fitted transit case. Carriage Paid.

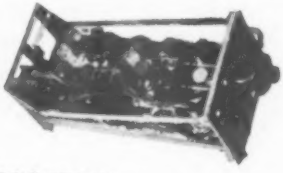


BATTERY CHARGER
Rectifier type 42A. Ref. 10D8/1630.
A compact battery charger. Output 4 amps at 6 or 12 volts D.C. Input 230 v. A.C. 50 c/s, with ammeter, removeable fuses, control switch for each circuit, input and output points, contained in well-ventilated black crackle metal case, dim. 12 x 6½ x 6in. for wall or bench mtg.
CLYDESDALE'S PRICE ONLY **£5 19 6** CARRIAGE PAID

FOR INEXPENSIVE TELEVISION

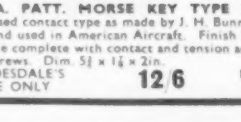


Indicator Unit Type 6M in maker's original case. Containing a VCR97 Cathode-ray Tube, with mu-metal screen, 4 VR91's (EF50), 3 VR54's (EB34), various w.w. pots, switches, H.V. Conds., Resistors, etc., built in metal chassis to fit into metal box 18 x 8½ x 7½in. All controls are brought to front panel beside viewing screen.
CLYDESDALE'S PRICE ONLY **£4 9 6** CARRIAGE PAID



R.3601 Receiver unit.
CLYDESDALE'S PRICE ONLY **£4 12 6** CARRIAGE PAID
R.3170A Receiver Unit.
CLYDESDALE'S PRICE ONLY **£4 12 6** CARRIAGE PAID
P.T. Reprints: The article by B. L. Morley on making a T.V. Receiver with Indicator Type 62. Price **1/6**

TEST METER TYPE E MADE BY AVO. Air Ministry Ref. 10S/10613
14 Test Ranges as follows:—
Two voltage readings f.s.d. at 1.25 mA or 2.5 mA, 2 v., 20 v., 200 v., 1,000 v. D.C. 20 mA, 100 mA, 200 mA, 2 A, 20 A. 10,000 ohms. Scale marked: 0-40 amps Volts. 0-20 Amps Volts. 0-10 Amps Volts. 0-5,000 ohms and infinity. Dimensions: 4½ x 3½ x 1½in. overall. Each instrument factory re-conditioned and tested by experts. Less Battery (Ever Ready U.10 1.5 V.) and leads.
CLYDESDALE'S PRICE ONLY **79 6** Each POST PAID



U.S.A. PATT. MORSE KEY TYPE CJB.
Enclosed contact type as made by J. H. Bunnell & Co. and used in American Aircraft. Finish black crackle complete with contact and tension adjusting screws. Dim. 5½ x 1¼ x 2in.
CLYDESDALE'S PRICE ONLY **12 6** POST PAID

Order direct from
CLYDESDALE SUPPLY CO., LTD. 2 BRIDGE STREET GLASGOW · C5
Phone: South 2706/9 Branches in Scotland, England and Northern Ireland

C.R.T. MASKS. Brand new.
LATEST ASPECT RATIO

9in.	7/6
10in.	7/6
12in.	15/-
12in. flat face	15/-
15in.	15/-

SOILED Old aspect ratio.

9in.	5/-
12in.	7/6
15in.	10/-
12in. with fitted armour plate glass. New aspect ratio	11/6

ARMOUR PLATE GLASS

12in. Actual size 13in. × 10½in.	4/-
9in. Actual size 9in. × 8in.	3/-

MULTI RATIO FRAME OUTPUT TRANSFORMER
LASKY'S PRICE
10/6

THE NEW WIDE ANGLE COMPONENTS FOR THE LATEST 14 and 17in. RECTANGULAR AND 16in. METAL C.R. TUBES. All for 38 mm. working.

Line and frame scan coils. Type DC300	42/-
Width coil. Type GL18	10/-
Line linearity coil. Type GL16	10/-
Focus coil. Type FC302	35/-
Line output and EHT transformer, 10-16 kV. Type L308	50/-
Frame output transformer. Type FO305	21/-
ELAC. P.M. Focus magnets:	
For 14 and 16in. tubes	52/6
For 17in. tubes	57/6

BRANDENBERG R.F. E.H.T. UNITS
Output 6-9 kV. Brand new and unused. Supplied complete with EY51 and 6V6.
LASKY'S PRICE £6/6/-.

FRAME BLOCKING OSCILLATOR TRANSFORMER
LASKY'S PRICE
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T.V. SCANNING COILS

Manfrs. surplus, high resistance frame, low resistance line. **12/6**

Low impedance line and frame. **14/6**

Plessey. Low impedance line, and frame. **25/-**

TRIODE FOCUS MAGNETS
Fitted with vernier control, 35 mm.
LASKY'S PRICE
15/-

DE LUXE TELEVISION CABINETS

For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster, "Practical Television," "Practical Wireless," and "Wireless World" televisors.

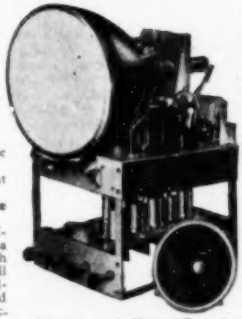
LASKY'S PRICE £8.10
Carriage 12/6 extra.

Outside dimensions of cabinet: 17½in. × 16½in. × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

TELEVISION SELENIUM RECTIFIERS
The very latest "Sentercell" S.T.C. range.

K3/40, 3.2 kV.	7/6
K3/45, 3.6 kV.	8/2
K3/50, 4.0 kV.	8/8
K3/100, 8.0 kV.	14/8

THE VIEWMASTER



The television set you can build at home from standard parts.
Wenvoe, Kirk o' Shotts, Holme Moss, Sutton Coldfield and Alexandra Palace operation. Brilliant high definition black and white picture.
Superb reproduction.
Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.
Incorporates all the latest developments.
Television for the home constructor at its finest.
Send to-day for the CONSTRUCTION ENVELOPE, a 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions. Model "A" for use in London and Home Counties. Model "B" for use in Sutton Coldfield Area. Model "C" for Holme Moss. Model "D" for Kirk o' Shotts. Model "E" for Wenvoe.

PRICE 7/6 per copy.
Post free

ALL COMPONENTS IN STOCK AND SOLD SEPARATELY.

CATHODE RAY TUBES
All types and sizes in stock, available for immediate delivery. Brand new and fully guaranteed.
9in. from £13/13/8.
12in. from £18/4/10.
15in. from £22/16/10.
16in. £24/6/5. 14in. Rectangular £22/8/5.
17in. Rectangular £26/19/8. Carriage and insurance extra.

CO-AXIAL CABLE
Standard impedance. Single screened, 1/- per yard. Twin screened, 1/6 per yard. Twin balanced feeder, 7½d. per yard. Post extra. Any length cut to your requirements. 10 per cent. discount on orders for 50 yards or more.

VIEWMASTER COMPONENTS

METAL RECTIFIERS

WX3 and 6. Each	3/9
14D36	11/8
14A86	20/4
36EHT100	29/6

VALVES
EF50's: 4/3, 6/6, 8/6 and 12/6 each.

EBC33	11/7
6P25	15/10
6K25	15/1
6P28	25/1
EB91	10/6
EY51	24/4

W B & PLESSEY

Line EHT trans.	32/6
Frame trans.	25/6
Boost choke	5/9
Width control	10/-
Scanning coil	33/3
Main choke	15/6
Focus ring	22/6
Heater trans.:	
WB/103	42/6
WB/103A	52/6
C.R.T. supports	21/6

COILS
All models, including filter chokes. Wenvoe, Kirk o' Shotts, Holme Moss, Sutton Coldfield, 28/- per set. Alexandra Palace, 20/- per set. L9 RF choke, 2/-.

CHASSIS
Sound-Vision, 18/6. Power-Pack/Time base, 18/6.
Support for P.P. chassis, 6/-.

CONDENSERS
All by T.C.C.
100 mfd. CE10LE, 14/-. 250 mfd. CE10DA, 10/-. 2,500 mfd. 3 v.w. CE25AA, 6/9. .001 mfd. 6 kV. 4/6. .001 mfd. 12.5 kV., 7/6. All other types in stock.

LASKY'S RADIO

Lasky's (Harrow Road) Ltd.,

370 HARROW ROAD, PADDINGTON, LONDON, W.9

(Opposite Paddington Hospital)
Telephones: CUNningham 1979 and 7214
Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

Terms: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

LASKY'S RADIO

"World Renowned for Service & Reliability"

P.M. LOUDSPEAKERS

All less o/trans. new and unused. First quality.

3in.	12/11
5in.	12/6
6½in.	12/6
8in.	14/6
10in.	17/6
12in.	75/-

SMOOTHING CHOKES

20 m/a. 40 H.	3/11
40 m/a. 8 H.	3/11
40 m/a. 10 H.	4/3
100 m/a. 10-20 H.	7/3
150 m/a. 3 H.	3/6

CONDENSERS

TUBULAR WAXED

500 v.w. .1, .01, .02, .05, .001, .002, .005, etc., etc. **6d.** each, 5/- doz.

MINIATURE MICA

100, 200, 300, 500 PF, etc. **6d.** each, 5/- doz.

CERAMIC AND SILVER MICA

All values from 4½**d.** each, 4/- doz.

MINIATURE

.1, .01, .001, .02, .002 mfd., etc. 7½**d.** each, 6/- doz.

8 mfd. 450 v.w.,	2/3
8 mfd. 500 v.w.,	2/11
8+8 mfd. 500 v.w.,	4/6
8+16 mfd. 500 v.w.,	5/3
8 mfd. 350 v.w.,	1/6
16 mfd. 350 v.w.,	2/6
50 mfd. 12 v.w.,	1/11
25 mfd. 25 v.w.,	1/11

.04 mfd. 12.5 Kv., latest plastic case, single bolt fixing, Visconol, 7/6.

MINIATURE BIAS

10 mfd. 25 v.w., 10½**d.** each, 9/- doz.

32+32 mfd. 350 v.w. and 25 mfd. 25 v.w. in single aluminium can. Latest fixing, 4/11 each.

32+100 mfd. 450 v.w. condensers, 7/6 each.

24 mfd. 450 v.w. 4/6.
12+12 mfd. 350 v.w. 2/11.
32+32 mfd. 450 v.w. 6/11 each.
16+16 mfd. 450 v.w. 5/3 each.

OUTPUT TRANSFORMERS

Pentode	3/6
Midget pentode	4/3
Push Pull pentode, 10 watts	12/6
Miniature, for 3S4/1S4	3/11
Push pull intervalve for PX4's	8/6

CRYSTAL DIODES

G.E.C. type, Glass wire ends, 3/3 each. B.T.H. Type, Plastic, 3/- each.

INTERCOM EQUIPMENT

Master unit. Incomplete. Comprises 16+16 mfd. 450 v.w. condenser, 2 Yaxley switches, input and output transformers, valveholders, etc. Less all valves and S-R. switch 15/-

Cabinet for master unit. Pleasing walnut finish 18/6

Extension speaker cabinets. Similar in design to the master cabinet. For use with 3in. speakers. 9/11

Carriage 2/6 per item extra.

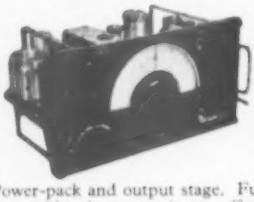
SPECIAL OFFER

BRAND NEW AND UNUSED R1155 RECEIVERS

AERIAL TESTED BEFORE DESPATCH

THESE SETS ARE THE TOPS

Supplied complete with 10 valves. Circuit: B.F.O., A.V.C., R.F. Amp., two I.F. Stages, magic eye, etc., etc. 5 Frequency ranges: 18.5-7.5 Mc/s.; 7.5-3.0 Mc/s.; 1, 500-600 Kc/s.; 500-200 Kc/s.; 200-75 Kc/s.



LASKY'S PRICE

£12.19.6

FREE WITH EVERY NEW R1155 RECEIVER—A SCRAP 1155 (less valves) value £2—£3. Ideal for spares.

Carriage 12/6 extra

Power-pack and output stage. Fully assembled. For use with above receiver. Complete with valves, wired and working. For operation on 200-250 volts 50 c.p.s.

LASKY'S PRICE 79/6 carriage 5/- extra.

IF PURCHASED WITH R1155.

SOLD SEPARATELY, PRICE 99/6. carr. 5/- extra.

25 WATT AMPLIFIERS

Brand new, famous manufacturer's surplus. For use on 200-250 volts 50 c.p.s. mains. Absolutely perfect, uses 7 valves in all, with two 6L6's in push pull. Also includes a medium and long wave tuner unit.

LASKY'S PRICE £25.0.0.

Carriage and packing 25/- extra.

J.RA.2. 10-12 WATT CHASSIS AMPLIFIER

For use on 200-250 volts 50 c.p.s. mains. Uses an L63 feeding 2 KT61's in push pull. U50 rectifier. Chassis size: 6in. × 17in. × 2in.

LASKY'S PRICE £7.19.6

Carriage 10/- extra.

Send 3d. stamp with name and address for details of the J.RA.2.

EPICYCLIC DRIVES

Standard type, 1/6. Special double type, 2/11.

SPECIAL COIL BUY

Superhet dual wave coil, medium and long. Aerial and oscillator. For 465 kc/s. I.F. Supplied with circuit,

LASKY'S PRICE 2/11

per pair. Post 9d extra.

For short wave, 25-95 metres. Aerial and oscillator. With circuit diagram.

LASKY'S PRICE 1/11

per pair. Post 9d. extra.

SOLON-HENLEY ELECTRIC SOLDERING IRONS

Brand new and unused. Supplied with fitted heavy rubber mains lead. Pre-Increase prices

Oval Bit. For 230/250 volts only

LASKY'S PRICE 19/-

Postage 1/- extra.

ANTENNA ROD SECTIONS

Steel heavily copper plated. Each rod is 12in. long and ¼in. diameter, any number can be fitted together.

LASKY'S PRICE 2/6 per doz. 6/- for 3 doz. 11/- per half gross; 20/- per gross. ALL POST FREE.

CAR RADIOS

HALF PRICE OFFER BRAND NEW AND UNUSED

In maker's cartons

★12 volt. ★6 valves. ★R.F. Stage. ★L. & M. Waves. ★Black crackle finish. ★Tone control. ★A.V.C.

£15.19.6

Carriage 10/- extra. Send for full details. A few only 6 volt models available. Also available Medium and Short wave models.

LASKY'S

Lasky's (Harr

370 HARROW ROAD, PA

(Opposite Paddington Hospital)

Telephones: CUNningham 1979 and 7214.

Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

TELEVISION PRE-AMPLIFIERS

For London frequency. 2 Stage, uses 2 6F13 valves. Completely wired, ready for use.
LASKY'S PRICE 15/-
(less valves)

VCR97 C.R. TUBES. BRAND NEW AND UNUSED

In makers' original sprung wood transit case.
LASKY'S PRICE 40/-
Carriage 5/- extra.

E.H.T. TRANSFORMER FOR VCR97

Primary: 200-250 v., 50 c.p.s.
Secondary: 2.5 kV. 4 mA.; 4 v., 1.1 a.; 4 v. (CT) 1.5 a.
LASKY'S PRICE 45/-
Postage 1/6 extra.

WEARITE I.F. TRANSFORMERS. Type 550

Permeability tuned, 445-520 Kc/s. Type 551. Critically coupled, with top grid connection. Type 552. Closer coupling for feeding diode circuit. Q115, inductance 700 micro-henries at 465 Kc/s. Bandwidth of each of the above transformers is 7-20 Kc/s at 2-20 dbs. Size: 3¼in. high, 1¾in. square. Supplied with fixing screws and nuts.
Per pair **12/6**

COIL PACKS

3 wavebands, 12-35 metres; 35-100 metres; 200-550 metres. ¼in. spindle, 1¼in. long wave-change switch. Completely assembled and wired. Size: 4in. x 4in. x 3in. BRAND NEW AND UNUSED.
LASKY'S PRICE 16/-
Circuit available 6d. extra.

THROAT MICS

Low level. With band, 2/6.

6in. ENLARGER LENSES

Oil-filled plastic 19/6. Carriage 2/6 extra.

FILAMENT TRANSFORMERS

Special Transformer. 30 volts at 2 amps, with the following tappings:— 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts, 21/-

USED CATHODE RAY TUBES

FOR CALLERS ONLY

9 inch C.R. TUBES

These tubes have h-c shorts and/or ion burns, and are ideal for testing or experimental purposes.

35/-

MAINS TRANSFORMERS

All 200-250 volts c.p.s. primary. Finest quality, fully guaranteed.

MBA/3. 350-0-350 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. An ideal replacement trans.
Price 21/-

MBA/5. 350-0-350 v. 125 mA., 6.3 v. 4 a., 5 v. 3 a. With mains tapping board. Price 27/6

MBA/6. 350-0-350 v. 100 mA., 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6

MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts.
Price 21/-

AT/3. Auto transformer. 0-10-120, 200-230-250 volts, 100 watt
Price 19/6

AT/4. Auto transformer. 100 volts and 230 volts. Step up or down. 60 watts. Price 9/6

LARGE STOCKS of RESISTANCES ALWAYS AVAILABLE

All values. Prices: 1/10th and 1/8th watt, 7½d. each; ¼ and ½ watt, 4d. each; 1 watt, 8d. each. Postage extra.

CARBON POT METERS

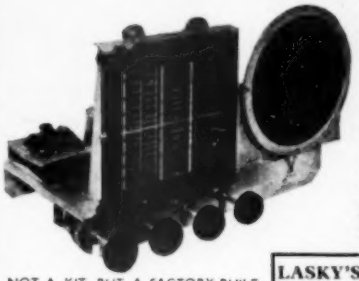
All with long spindle, ¼, ½, 1 and 2 meg.
LASKY'S PRICE less switch, each 3/3
With switch 4/3 each. All post extra.

RECEIVER UNIT TYPE 153

45 Mc/s I.F. STRIP. Contains 4 RF stages, detector, video amplifier and phase splitter. Uses 6 EF50 and 1 EA50. Supplied complete with all 7 valves.
LASKY'S PRICE 63/- Carriage 3/6 extra.

LASKY'S RADIO
1947 — World Renowned for Television Reliability

ALL-WAVE RADIO CHASSIS!



* 5 new valves.
* 8in. Elac p.m. speaker.
* Variable tone control.
* Large edgelit dial, 7½in. square.
* 2-speed tuning with nylon drive.
* 4-watt output.
* Sockets for p.u. and extension speaker.
* 465 Kc/s I.F.
* A.V.C.
* Circuit diagrams.

Size of chassis: 15½in. wide 8in. deep, 7½in. high.

NOT A KIT, BUT A FACTORY-BUILT JOB. FULLY ALIGNED AND TESTED.

LASKY'S PRICE
£10.19.6
Complete with 5 valves and speaker.
Carriage and insurance 10/6 extra.

Enclose 2½d. stamp for full details, circuit diagrams and illustrations.

A limited supply of walnut plastic cabinets, suitable for use with this receiver is available at 45/-, carriage extra.

EX AMERICAN AIR CORPS ANTENNA RELAY UNITS TYPE CBY 29125

BRAND NEW AND UNUSED. Contains a 0-5 m/A. M.c. meter, also relay, insulators, 0.75 amp heating element, a 50 pf. 5 Kv., vacuum condenser, etc. In metal case, size: 4½ x 5 x 3½in.
LASKY'S PRICE 10/-

INTER-COM. SETS

4-station operation. For use on AC/DC mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in pleasant plastic cabinet.

Complete with one extension as illustrated.
£8.19.6

RADIO

ow Road) Ltd.,

DDINGTON. LONDON. W.9

TERMS: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

B.T.R. GRAM MOTORS

MU10. Single-speed motor. Without p.u., £3/18/-.
MU14. 3-speed motor. Without p.u., £6/8/6.
GU4A. 3-speed motor, fitted with lightweight high fidelity crystal pick up, £9/19/11.
Carriage 5/- per unit extra.

COLLARO TAPE DECK MOTORS

Price 42/- each.

EX-GOVERNMENT VALVES

VU120A	2/6	PT25H	5/-
VU111	3/6	E1148	2/6
APV4	12/10	RK34	2/6
57	3/6	MH14	4/6
32E	2/6	S130	4/6
		NGT1	5/-

Tungar charger recs. From 12/6
Screen grid, 2 v., 4/6
EF50's, 4/3 and 5/6 each. Also 1D5 at pre-budget price of 11/-.
HUNDREDS OF OTHER TYPES IN STOCK.

PACKARD BELL TYPE K PRE-AMPLIFIERS

BRAND NEW AND UNUSED. Contains 2 valves 1 6SL7 twin triode, 1 28D7 twin pentode. Also associated components, input and output transformers, etc. Contained in light-weight metal case 4½ x 5 x 4in. Designed to increase the output of low gain microphones and pick ups. Supplied with full data and circuits.
LASKY'S PRICE 19/6
Carriage 2/6 extra.

EX A.M. FREQUENCY METER TYPE W1191

BRAND NEW AND UNUSED. In makers' original wood transit case. Frequency range 100 Kc/s to 20 Mc/s continuous. Uses 4 valves and a 100 Kc/s crystal. Battery operated 2 volt LT and 60 volt HT. Unit contained in grey metal case, with hinged lid and web carrying-strap Size: 12 x 10 x 10in., weight 30 lbs. Supplied complete with all valves, crystal. Accuracy 0.1 per cent. and with crystal 0.01 per cent.
LASKY'S PRICE **£8.19.6.**
Carriage and packing 10/- extra.

TWO-GANG TUNING CONDENSERS. .0005MFD.

No. 1. Miniature. With Perspex dust cover and trimmers. Size: 1½ x 2 x 1¼in., ¼in. spindle.
LASKY'S PRICE **8/6**

No. 2. Midget. With trimmers. Size: 2½ x 1¾ x 1¼in., ¼in. spindle.
LASKY'S PRICE **8/6**

No. 3. Standard type. Size 2½ x 2½ x 1¼in., ¼in. spindle.
LASKY'S PRICE **6/6**

THREE-GANG TUNING CONDENSER. .0005 mfd. Size: 3½ x 2½ x 1¼in., ¼in. spindle.
LASKY'S PRICE **7/6**

R.F. 24 UNITS

Supplied complete with 3 brand-new Mazda SP61 valves.
LASKY'S PRICE **25/-**
Carriage 2/6 extra.

BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE

You're SURE to get it at

STERN'S

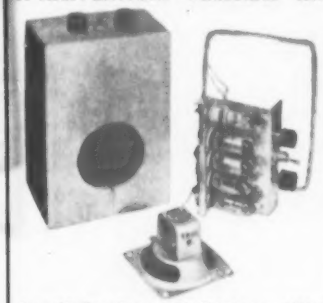
ESTABLISHED 25 YEARS

ALL KITS INCLUDE "EASY TO FOLLOW" POINT-TO-POINT WIRING DIAGRAMS

A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.
Designed to operate on A.C. mains 200/240 volts, or by an "Alldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied (a) as an "Alldry" Battery Superhet Personal Set which can then be accommodated in the Attache Case as illustrated above (size 9½in. × 4½in. × 7½in.). This is attractively finished in dark green or blue texite (b) or as a Combined Mains-Battery Superhet Portable Receiver, for which a polished Wood Cabinet is available to accommodate both Mains and Unit Batteries together. Circuit incorporates delayed A.V.C. and Pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound Frame Aerials, fully aligned I.F. Transfs., and drilled Chassis, etc. Overall size of assembled chassis 9in. × 4½in. × 7½in.
We can supply the set either as a complete Kit of Parts for £10.7.6 (inc. P.T.) (excl. Cabinet and Mains Unit), or by supplying the components separately. The complete Assembly Instructions, which include full price details (including prices of individual components), Circuit and Component Layout, etc., are available for 1/9 (incl. postage).
Attache case as illustrated. 37/6.

A T.R.F. BATTERY "PERSONAL" KIT



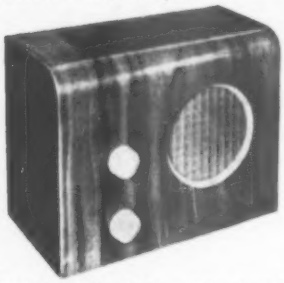
A complete Kit of Parts to build a Midget 4-valve "Alldry" Battery Portable Set, covering medium wavebands.
Consists of Regenerative T.R.F. circuit employing Flat Tuned Frame Aerial with Denco Iron Dust Cored Coil.
Valve line up, two 1T4's (R.F. Amp. and Det.), 1R5 and 1S4 output.
Kit is complete in every respect and includes drilled Chassis and latest type 5in. Dia. P.M. Speaker. Overall size of assembled Chassis 6½in. × 9in. × 5½in.
We can supply the Complete Kit (less cabinet) for £6.12.6 (incl. P.T.) or by supplying the components separately. The Complete Assembly Instructions, including full Circuit, Component Price, Circuit and Component Layout, etc., are available for 1/- (incl. post).

A KIT OF PARTS

Complete in every detail, to build a 3-valve Amplifier for A.C./D.C. mains 200-250 volts.
Has an output of 3 watts, and incorporates a Tone Control.
Valve line up, 25A6, 6J7, CY1.
Our price of £4.18.9 for complete Kit includes a matched 6½in. P.M. speaker.
This Amplifier can also be supplied assembled and ready for use for £5.19.6.

A MIDGET 4-STATION "PRE-SET" RECEIVER

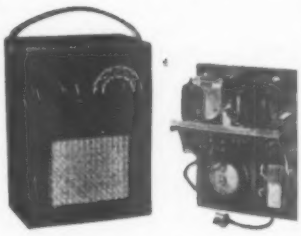
A complete Kit to build a 4-station "Pre-Set" Superhet Receiver for A.C. mains operation.
The Set is designed to receive any three Stations on medium waveband and one on long wave, each Station being received by the turn of a Rotary Switch.—No Tuning being necessary.
It is of midget size, being 8½in. × 4½in. × 7in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price.



Price of complete Kit of Parts (including aligned I.F. Trans. and drilled Chassis, etc.), £9.15.- (incl. P.T.) (plus Cabinet 25/6), or the components can be purchased separately. The complete Assembly Instructions, including Individual Component Price List, Circuit and Component Layout, etc., are available for 1/9.

THE "MINI TWO-THREE" BATTERY PORTABLE

An "Alldry" Battery Portable of midget size, 6½in. × 4½in. × 7½in., designed to cover medium waveband 190-550 Metres, with use of short trailer Aerial.

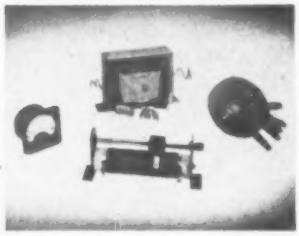


The simple design of this Receiver is so arranged that either a 2-valve Set, or a 3-valve (afterwards easily converted to the 3-valve) can be made.
Consists of a T.R.F. circuit, using a Regenerative Detector with H.F. Stage, and a High Gain Output Pentode. Valve line up 1T4—1T4—1S4.
The 2-valve Set can be completely built for £4.3.6 (less Case), and the 3-valve for £5.3.- (less Case). Each price includes Valves, Speaker and drilled Chassis.
Send 2/- for the Assembly Instructions, they include simple and complete Practical Component Layouts and Diagrams which enable the most inexperienced constructor to successfully build either Set. All Components are available for separate sale, a price list being supplied with the Assembly Instructions.

THE "WIRELESS WORLD" 3-VALVE SET

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.
We are able to supply all of the components to build this set, as designed, and specified in the Feb. 1950 issue, including the drilled Chassis. Valves and moving coil Speaker, etc., at the following prices:—
To construct complete Chassis, less Dial and Drive Assembly, £5.5.-. Dito, including Dial and Drive Assembly, £6.
To construct the complete Set, including Dial and Drive Assembly and Cabinet, £7.3.6.
Overall size of Cabinet is 7½in. × 8½in. × 11½in.
A reprint of the designer's article, giving Circuit and Assembly Instructions (this is available separately for 9d.), together with a Practical Component Layout is included with each of above assemblies.

BATTERY CHARGER KITS



All Kits incorporate Metal Rectifiers, and are for use on A.C. mains 230-250 volts. All Kits include an easily followed Wiring Diagram.
For charging 2- 4- or 6-v. batteries at 1 amp., £1.8.-.
For charging 6-volt battery at 1 amp. with Variable Resistor and Meter, £2.12.6.
For charging 12-volt battery at 1 amp., £1.9.3.
For charging 12-volt battery at 1 amp., with Variable Resistor and Meter, £2.14.-.
For charging 6- or 12-volt battery at 2½ amps, £3.1.-.
For charging 6- or 12-volt battery at 2½ amps., with Variable Resistor and Meter, £3.8.3.

THE "WIRELESS WORLD" MODERN CRYSTAL SET

Designed for the Pre-selection of THREE STATIONS to suit local conditions, each Station being received by the turn of a Rotary Switch. We are able to supply all components, including drilled Chassis to build this new type of Receiver, to the designer's specification, as published in October issue, for 47/4 (including cost of selected coils). A reprint of the designer's article (available separately for 9d.) together with a practical component layout, make the assembly very easy.

★ *Send 9d. P.O. for our STOCK LIST, it shows "hundreds" of Wireless*

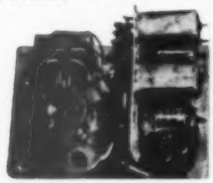
When ordering please include

STERN RADIO LTD., 109

Tel: CENtral

THE "PRACTICAL WIRELESS" "MINI FOUR" BATTERY PORTABLE

A 4-valve Battery Superhet Receiver designed to receive 4 Pre-set Stations three on medium waveband and one on long wave to suit local conditions. Each Station is obtained on the set by the turn of a Rotary Switch. No tuning is necessary.

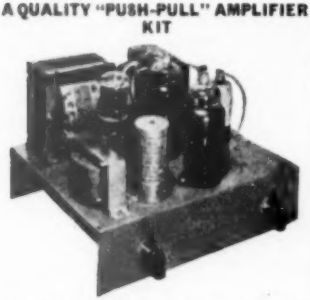


It is of midget size, being only 41in. × 6¼in. × 4¼in. when completely built, and is very easily assembled from diagrams supplied.

Cost of all components to build this Set, in accordance with the design, including a drilled and cut chassis and panel, and new valves, is **£9 10**/- (or less valves for **£8 7 6**. Attractive carrying case finished in blue leatherette, **16 9**. Complete constructional data with a blue print, which shows the Practical Component Layout and Wiring Diagram, together with an Individual Component Price List, is available separately **1 6**.

Our Battery Eliminators (illustrated below) available in kit form are suitable for use with this set.

A QUALITY "PUSH-PULL" AMPLIFIER KIT



A Kit of Parts to build a 6-8-watt Push-Pull Amplifier for operation on A.C. mains 200-250 volts.

Incorporates a simple arrangement to enable either a magnetic, crystal, or lightweight pick-up to be used.

A 10-watt Output Transformer is designed to match from 7 to 15 ohm speakers. Tone control is incorporated.

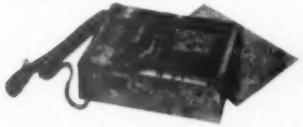
The overall size of the assembled Chassis is 10in. × 8in. 7¼in. high. Price of Kit complete in every detail, including drilled Chassis, and Valves, **£6 12 6**. Component Layout is supplied.

Price of assembled Chassis, supplied ready for use, **£8 2 6**.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build a Midget "Alldry" Battery Eliminator, giving approx. 69 volts and 1·4 volts.

This Eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to fit volts.



The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4½in. × 14in. × 3½in. Price of complete Kit with easy-to-follow Assembly Instructions, **42 6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1·4 volts. Size of assembled Unit 7in. × 2½in. × 14in. Price **47 6**.

You're SURE to get it at

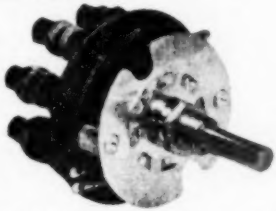
STERN'S

ESTABLISHED 25 YEARS

TWO NEW DENCO ULTRA MIDGET SUPERHET COIL TURRETS Both having a Rotary Turret Action

(a) The C.T.9 Turret consists of 6-STATION PRESET UNIT from which any three Stations on medium waveband and one on long wave can be received by a turn of the Turret Switch.

(b) The C.T.10 Turret being a 3-waveband Coil Pack, incorporating a fourth switch position providing for completely switching out Radio when Mains Drain. The complete coverage is: long waveband 700 to 2,000 metres; medium wave 180 to 570 Metres and short waves 13 to 50 Metres.



The outstanding advantages these units have over other similar units can be readily seen, the main features being:

(a) Neat and compact, the overall size being only 2¼in. dia. × 1¼in. deep.

(b) Fitting is simplicity itself, each Turret having one hole fixing and requiring only four connections.

(c) The Rotary Turret design switches the actual Coils, which incorporate variable iron dust cores, on to positive contacts, thereby reducing stray capacities to the absolute minimum.

(d) They are supplied Factory wired and aligned and have been designed to operate with any conventional circuit arrangement of 465 Kc/s, and due to their unique design are extremely sensitive and efficient.

Price: C.T.9 Turret, **42 10**. C.T.10 Turret, **52**/-.

A complete Receiver Circuit together with leaflet containing all necessary data is included with each Turret. These can be supplied separately for **2d**.

STERN'S "RADIO TUNER MANUAL." Price **2 6**. (Plus 3d. Post). Contains complete and detailed Assembly Instructions showing how to make:—

A 4-valve T.R.F Tuning Unit, covering long and medium wavebands.

A 4-station "Pre-set" Superhet Tuning Unit, producing 3 Stations on medium waveband and 1 on long wave.

A 5-Valve Superhet Tuning Unit, covering short, medium and long wavebands.

Each Tuner is for A.C. mains operation. Circuit Diagrams and Practical Component Layouts are shown, together with Complete Component Price Lists.

PICK-UPS

Cosmocord "G.P.20," for standard records, **£3 11 5**; interchangeable (G.P.19) Head for L.P. records, **£2 3 4**.

Decca lightweight "turnover Head" type, or L.P. and standard records, **£3 19 2**.

Marconi, Standard, lightweight Magnetic, **£1 15 10**. Marconi Matching Transformer, **7 6**.

Goldring, Standard, lightweight, Magnetic, **35 10**.

THE "WIRELESS WORLD" MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including Valves and Moving Coil Speaker for **£3 10**/-, including Instructions. Complete Building Instructions (these are available separately for **2d**.).

THE FAMOUS W.B. "STENTORIAN" RANGE OF P.M. SPEAKERS

Size.	Impedance.	Watts.	Price
2½in.	2-3 ohms.	1	18 6
4in.	"	2	19 6
5in.	"	3½	21/-
6in.	"	3	22 6
8in.	"	5 (also in 15 ohms)	22 6
9in.	"	7	35 9
10in.	"	10 (also in 15 ohms.)	44 6
12in.	15 ohms	15	69

New Electrolytic Condensers. Not Ex-Govt. All 450/500 volts: 8 mfd. (1¼in. × 1in. dia.), 3/-; 8-8 mfd. (1¾in. × 1in.), **4 9**; 16-8 mfd. (1¾in. × 1in. dia.), **5 6**; 16-16 mfd. (1¾in. × 1¼in. dia.), **5 9**; 32 mfd. (1¾in. × 1¼in. dia.), **5 9**; 32-32 mfd. 350 volt, **5 9**; Cardboard Tubular 4mfd. 500 v. **3 6**; 8 mfd. 500 v., **4**/-; 16 mfd. 500 v., **5 9**. Can Standard size all 500 volts, 4 mfd., **3 6**; 8 mfd., **4 3**; 8-8 mfd., **5 9**; 16 mfd., **5 6**; 16-16 mfd., **7 9**; 32 mfd., **8 9**.

Denco I.F. Liner, for accurately lining 465 Kc/s and 1·6 M/c I.F. channels, and associated circuits. Battery operated, small and completely self-contained. **50 6**.

Potentiometers. New not Ex-Govt. 2K, 5K, 10K, 25K, 50K, 100K, 250K, 1, 1 and 2 meg. Price, less switch, **3 9**. Price with S Pole switch, **5 9**. Price with D Pole switch, **6 6**.

Surplus Potentiometers. All standard with extended spindles, 5K, 10K, 15K, 20K, 25K, 50K, 100K, ¼, ½ and 1 meg., **2**/- each.

Televisors. We keep a very comprehensive range of T/V components. The Viewmaster T.V. Assembly Instructions showing Practical Layout and Price List in stock, price **7 6** (incl. post). We can supply all the specified components for the T/V set in stock either by way of individual components or by the published stages.

THE FAMOUS "SHAFTESBURY" RIBBON MIKE incorporating internal line Transformer having transformation ratio from ribbon impedance up to 500/600 ohms. Reduced from £10/10/- to **£6**.

A special line to grid, 500/500 ohms, Transformer is also available for **25**/-.

Coils. Denco "Maxi Q," midget size, Litz wound on Polystyrene Formers, with adjustable iron cores. Available for Aerial H.F. and Oscillator 465 Kc/s or 1·6 M/s. **3 11** each, or with reaction winding **4 9**. Denco Matched pair T.R.F. Coils for long and medium waves, **8**/- pr. Weymouth matched pairs of coils, for T.R.F. covering long and medium waves, **10 3** pr., or for Superhet covering long, medium and short waves, **12 3** pr. All types of Wearite "P" coils in stock at **3**/- each.

Coil Packs. Osmor Midget Coil Pack. Size 3½in. × 2½in. × 1¼in., covering S., M. and L. waves. Coils wound on Polystyrene Formers with adjustable iron cores ensure efficient performance. Factory wired and aligned. Price (including full circuits for Superhet 465 Kc/s Unit), **52**/- (incl. P.T.). This Osmor Coil Pack is also available for Midget Superhet BATTERY Portable Sets, including a matched ready-wound Frame Aerial. Price **54 2** (incl. P.T.). **Weymouth Midget** 3½ × 2½ × 1¼in. covering S.M.L. wbands, for 465 Kc/s, employing matched iron cored coils on each waband, **51 6**.

Wearite Pack. 4½ × 3½ × 1¼in. Type 706, covers two short w bands and medium waband only. Type 702 covers short-medium-long waves. Both for 465 Kc/s. Incorporates trimm. position and employs adjustable cored coils, **53 6**.

All of the above Coil Packs include Switching, Padding and Trimmer Condensers.

I.F. Cookes. Midget 10 henry 250 ohms 50 mA. **4 6**; 20 hys. 250 ohms, 60 mA, **6 6**; 20 hys. 500 ohms, 100 mA, **13**/-; 5 hys. 50 ohms, 250 mA, **26 6**; 20 hys. 250 ohms 120 mA, **15 6**; 9 hys. 250 ohms 120 mA, **8 6**; 18 hys. 250 ohms 200 mA, **26 6**.

I.F. Transformer 465 Kc/s. New well-known manufacturer's surplus. 2in. × 2in. × 1¼in. Iron core, 9/- each and also size 1in. × 1¼in. × 2¼in. at **12 9** per pair. Each have adjustable iron core. Denco 1·6 m/c core, 465 Kc/s, or 1·6 M.c., 4½in. × 1¼in. × 2¼in. **19 6** pair. New Surplus 465 Kc/s, Iron core, 4in. × 1¼in. sq. **10**/- pr.

Transformers. (a) Input 230 volt, output 200 volt 25 mA and 6·3 v. 3 amp. **11 9**; (b) Input 250 volts, output 250 volts 30 mA, and 6·3 v. 2 amp. **14 6**.

E.H.T. Transformer. Prim. 230 v. Sec. 5 Kv. and 4 volt tapped 2 volt, **59 6**. Do. but 4 Kv., **54**/-.

Filament Transformer. Inputs 230 volts, outputs 6.3 v. 1½ amp., **8 3**; 4 v. 1½ amp., **7 6**; Input 200/250 v. output 4 v. (C.T.), 1½ amp., 4 v. 1 amp., 6.3 v. 2 amp., **19 6**. Input 230 v., output 6.3 v. (C.T.) 4 amp. **17 6**.

Metal Chassis, substantially made with four sides. 7in. × 4in. × 2½in., **3 11**; 9 × 5 × 2½in., **5 3**; 10 × 6 × 2½in., **6**/-; 10 × 7 × 2½in., **6 3**; 12 × 9 × 2½in., **7 9**; 14 × 9 × 2½in., **8 3**; 16 × 8 × 2½in., **9**/-.

S-w Mfrs. Surplus Transformers. Input 200 to 240 volts output 12 v. 8 amps., **21**/-.

Types. 14DE36, **11 3**; 16HT28, **12 6**; 16EHT36, **17 9**; 36EHT25, **13 10**; 36EMT35, **18 2**; 36EHT40, **20 6**; 36EHT45, **22 6**; 36EHT50, **24 10**; 36EMT60, **25 9**; 36EHT100, **29 5**; 36EHT15 **7 9**.

F Wave Bridge Rectifiers:

For charging 2, 4 or 6 volts at 1½ amps.	10 6
For charging 6 or 12 volts at 1½ amps.	13 6
For charging 6 or 12 volts at 3 amps.	21 6
For charging 6 or 12 volts at 4 amps.	25 10
For charging 12 or 24 volts at 3 amps.	25 9

A Variable Resistor for control of Charging Equipment (as Models) up to 3 amps. **17 9**, or for 1½ amps., **15**/-.

Motor Rectifiers. Westinghouse 250 micro-amp. **12 9**. 1 m.a. **11 9**; 5 m.a. **6 6**.

Selenium Rectifiers. H.T. H wave, 250 v. 50 mA. **6 6**. 250 v. 100 mA, **8 6**; 250 v. 170 mA **15 6**.

Charger Transformers. A.C. ratings. Suitable for use with preceding Rectifiers. Each has input of 220 volts. Outputs: (a) 24 volts tapped 15 v. 9 v. and 4 v. at 3 amps. **25**/-; (b) 30 volts tapped 15 v. and 9 v. at 3 amps. **26 3**; (c) 15 volts tapped 9 v. at 3 amps., **21**/-; (d) 17 volts 14 amps. **12 3**; (e) 15 volts tapped 9 v. at 6 amps. **24 3**; 15 volts tapped 9 v. at 1½ amps., **15 9**. 12 volts 1 amp. **7 6**.

A Battery Charger Wiring Diagram is included with purchase of Charger Transformer and Rectifier.

Adjustable Mains Droppers. 1½in. dia. × 2½in. (a) 1·2 amp 1,300 ohms, **5**/-; (b) ·7 amp. 1,800 ohms **4 3**; (c) ·3 amp. 600 ohms, **5**/-.

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Auto-wound, H.T. 280 volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separate 4 v. 3 amp. rectifier winding (upright or drop-through), **10/6.**

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Auto-transformer, various combinations of voltages including 110 v. 70 watts, and 3/4 volt windings at 1 amp., 2 volt 1 amp., drop-through or upright mounting, **10/6.**

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3½in.	—	11/6
5in.	15/-	11/6
6½in.	14/6	11/6
8in.	17/-	13/6

10in., 16/-, less trans.

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6½in. Energised Television Speaker by PLESSEY. Field resistance 68 ohms with humbucking coil. Will pass up to 300 mA., require minimum 200 mA. to energise. These are cheaper than a T.V. choke. **9/6** each. 2 for **18/-.**

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Expanded aluminium speaker fret 13½ x 9in., **2/-.**

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Trimmers. 5-40 pf., **5d.**; 10-110, 10-250, 10-450 pf., **10d.**

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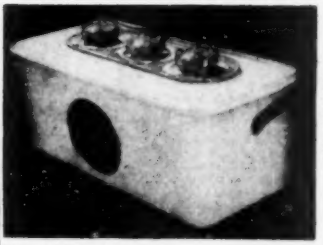
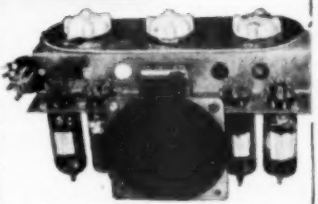


Personal Portable Cabinet. In cream-coloured plastic; size 7 x 4½ x 3in. Complete 4-valve chassis. Scale and 3 knobs. Takes miniature 90 v. and 7½ v. batteries. **9/-.**

2½in. P.M. Speaker to fit above, **13/6.** Miniature output transformer, **5/-.** Miniature wavechange switch, **1/6.** Miniature 1-pole 4-way used as Volume and Off, **1/6.** 4 B7G valve holders, **2/-.** Midget twin gang ·5in. dia., ·5in. long and pair medium and long-wave TRF coils ¾ in. long x ·5in. wide; complete with 4-valve all-dry mains and battery circuit, **8/6.** Condenser Kit, comprising 11 miniature condensers, **3/6.** Resistor Kit, comprising 12 miniature resistors, **3/-.** The above receiver (less valves and batteries) could be built for approximately **49/-.** All valves to suit above available. Point to Point Wiring Diagram, **1/-.**



View of chassis as it would look when assembled with valves inserted.

CONSTRUCTOR'S POLISHED CABINET. Size 10 x 6½ x 5in. approx., supplied in flatted form, grooved and ready to glue together. Complete with plastic front, 5 valve chassis, cadmium plated, size 8½ x 4 x 1½in., tuning scale, knob and back. Illustration as it would look when assembled. Two bottom knobs not supplied **10/-.** Plus 1/6 post and packing.

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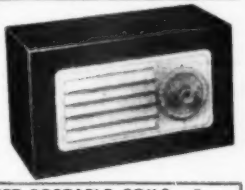

MAINS OR BATTERY SUPERHET PORTABLE COILS. Compr sing medium-wave frame aerial and long-wave loading coil, used as aerial coils. Midget iron-cored screened L.M osc. coils, complete with circuit I.F. frequency 465 Kc., **9/6.**

465 KC. MIDGET I.F.s. Q.120, size 1½in. long, 1in. wide, ½in. deep, by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, **12/6.** Both these items **£1,** post paid.

CONSTRUCTOR'S PARCEL comprising 5-valve superhet chassis with I.F. and electrolytic cut-outs, size 13 x 6½ x 2½in., complete with 3-wave band scale (new wave lengths), size 11½ x 4½in. approx., drum, drive spindle, back plate, two pulley wheels and five International Octal Paxolin valve holders. **11/6.** P. and P. 1/6.

6 IRON-CORED COILS on Aladdin formers 13.5-50 metres, 198-550 metres, 950-2,000 metres. Tuned with a .0005 gang, I.F. frequency 465 Kc. Complete with circuit, **8/6.**

METAL RECTIFIERS. 250 v. 60 mA., latest midget Selenium type, **6/6.** 250 v 100 mA. Midget Selenium, **7/6.** P. and P. 6d. each.

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 2 ohms speech coil, **4/9**; Push-pull 6V6 matching 10-watt 2-ohm speech coil, **6/9**; 42-1 speech coil 2-ohm with extra feed-back winding, **4/3**; Miniature 42-1 2ohm speech coil, **3/3.**

Twin-gang .0005 with separate 75 pf. on each section for S.W. tuning with feet, size 3½ x 3 x 1½in., **6/6.**

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40 mfd., 450 wkg. **3/9**
16 x 8 mfd., 500 wkg. **5/-**
16 x 16 mfd., 500 wkg. **5/9**
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1 mfd., 500 v. wkg. **1/6**
32 x 32 mfd., 350 wkg. **6/-**
32 x 32 mfd., 350 wkg. and 25 mfd., 25 wkg. **4/6**
25 mfd., 25 wkg. **11d.**
250 mfd., 12 v. wkg. **1/-**
16 mfd., 500 wkg., wire ends **3/3**
8 mfd., 500 v. wkg., wire ends **2/6**
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Frame O.P. Transformer. Inductance 10 henry, ratio 10 : 1. **9/6.**

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Same as above, but complete with 2—½ watt resistors and 1—¼ watt, .001 miniature and 5,000 ohms 3-watt vitreous, **5/-.**

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Similar to above, but with front adjustment, **2/6** each extra.

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465 Kc. I.F.s, size 2½ x 1½in. Q 110 removed from American equipment, **5/-** per pair.

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Standard 465 Kc. I.F.S, Q.120, iron-cored, 3½ x 1½ x 1½in., per pair, **9/6.**

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Two-piece Octal Screening Can, 9d. P. and P. 3d.

Three-bank, 50 pf., **13.** Four-bank, 50 pf., **18.**

AMPLIFIER CHASSIS, 18 gauge aluminium, 5 valve holders, transformer and 2 electrolytic cut-outs, size 11½ x 7½in., sloping front, **4/-** each.

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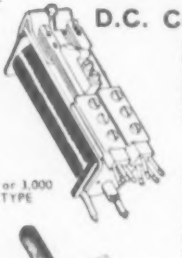

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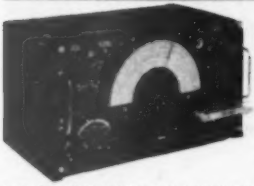

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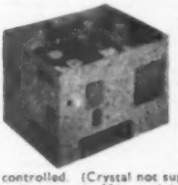

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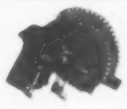

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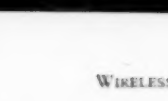

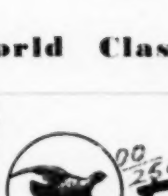

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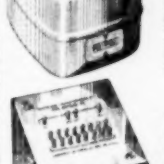

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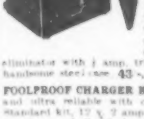

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250 Selenium rectifiers (S.T.C.), 12v, 4 amps, bridge, H.D. tags, 112mm discs, brand new, £200.—P. B. Crawshay, 166, Pixmore Way, Letchworth, Herts. [0241]

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MANY other bargain radio and television component lines in stock.
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Alloy Tube, 1.300in. O.D. (B.S.W.G. to Bist. A.W.10ft. All steel parts are sherardised to marine finish and guys of the finest quality galvanised wire rope, including spare grips and thimbles.

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VALVE HOLDERS. int. Oct. Bakelite **6d. ea.** Ceramic, 1/3 ea. B9G. Ceramic, **9d. ea** B9A, Laminated, **8d. ea.** 3-pin Diode, Laminated, **3d. ea.** 3-pin cradle type, Polystrene, **6d. ea.** B7G. Polystrene or Bakelite, 1/- ea. Ceramic mounted in pairs with screening cans, **5/6** per pair. Please add postage.

INERT CELLS. 1½ volts, size 2in. x 2in. x 5in. Just add water, last for years, ideal for Electric Bells, Telephones, Models etc. Only 2/- each. Post and packing 1/-. Or 4 for 10/- Post free.

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LOOK!—Plan position indicators containing 17 valves—2 VT60A (807) KTZ41, 2 DDL4, MH4, VR78, 7 VR65A, HVR2, 2 UU4, large 250-1/50 power pack giving 500-0-500v (twice) 6.3v-2.0-2v, 4v (twice), 4,000v EHT (approx.). M type motor with reduction gearing (worm and spur), scanning coils with slip-rings, large quantity of other parts, including 22 toroidal, W.W. and other pots, 24 Mansbridge condensers (11-10mfd 450v and others up to 5,000v), switches, 8 knobs (fluted), 14 jacks, fuses micro-switch, dial light, 70 vitreous and other resistances and condensers, etc.; the whole mounted in handsome heavy gauge steel cabinet, 20¼in x 27in x 60in high, finished in black, with hinged doors and plated handles; price (unused) £6.19.6 each (cabinet alone worth more).—K. M. Lotan, Westally, Hitchin, Herts. [0258

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WANTED.

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WANTED, receivers A.R.8, also T.N. 16, 17, 18, 19, etc., and any radio test gear.—LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176

WTD., power unit 114 for the T1154.—Herbert, 15, Ashley Rd., Parkstone, Dorset.

NICKEL chrome wires, 19-26 urgently wanted.—Doyle, 157, High Holborn, W.C.1. Chancery 4050. [5800

WANTED, quantity valves, type 805 and 866A; 805 must be either R.C.A. or G.E. manufacture.—Box 8783. [8765

500 bakelite earpieces, A.M. Ref. 10A/15466.—R. J. Boulting, Ltd., Bridge Road Works, Leicester. Tel. 67232. [8780

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WANTED, ex-W.D. Long afterglow electrostatic cathode ray tubes, type VCR87 or similar.—Room 63, Royal Technical College, Glasgow. [8776

WANTED, laboratory test equipment, including standard signal generator, watt meter, oscilloscope, bridges, recorders; send price and details to—HATFIELD INSTRUMENTS, 175, Uxbridge Rd., Hanwell, W.7. Tel. Ealing 0779. [7937

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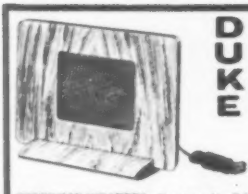
WANTED, 1155N, unmodified. 3cm. Radar equipment and spares; valves 5D21, 715B, QA12P. "Acoustical" amplifier, sale, Williamson and tone control £15.—53, Abbey Rd., Grimsby. [8798



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WE purchase all types of domestic or ex-Government radio receivers and equipment; send full details or call and collect cash; large or small quantities.—Walton's Wireless Stores, 48 Stafford St., Wolverhampton. [0146

WANTED, R.C.A. speech amplifiers type MI-11220 J or K and aerial tuning units BC 939 A. Hallicrafters speech amplifiers BC 614; offers, stating quantity and price to P.C.A. Radio, The Arches, Cambridge Grove, W.6.

WANTED, AN/APR-4 receiver, any units, any other good quality U.S. surplus radio and radar tubes, test sets, laboratory equipments, etc.; give condition and price in first letter.—Littell, Parhills, Box 26, Dayton 9, Ohio, U.S.A. [0254

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WANTED, new surplus valves of all descriptions, large or small quantities, types 723A/B, 805, 807, 813, 832, 100th, 250th, 2C40, 2C43, test instruments, receivers, transmitters, BC610, etc., best prices paid.—Write Pype-Hayes Radio, 606, Kingsbury Rd., Birmingham, 24. (Phone: Erdington 4942.) [0811

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MEMBERSHIP is essential to all actively engaged or interested in high-quality sound recording and reproduction. The fees are moderate, the benefits considerable; the 1952-53 season's programme is in preparation, and a new Centre has been opened in Manchester; all publications and the special test records are detailed on Publications List P.106. Particulars of Membership, which is world-wide, are available and include application form and List P.106. Write to the MEMBERSHIP Secretary, B.S.R.A., 48, Mount View Rd., North Chingford, E.4, England.

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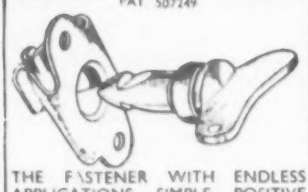

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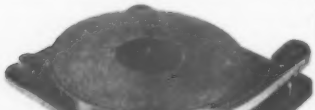

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ONE senior and several junior electronic engineers are urgently required by a large firm for work of national importance; successful applicants will be required to take over experimental radar and other circuits, and to collaborate with experienced component and mechanical engineers in the development of soundly engineered equipment for quantity production; applicants should have experience of layouts, allowance in circuit design for component tolerances, and an understanding of production methods.—Please write, giving full details of qualifications and experience and quoting ref. IBA, to Box 0516. [8675

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AERONAUTICAL service engineer required; duties will include installation, flight-testing and servicing, for which thorough practical and theoretical knowledge of a.c. and d.c. amplifier systems is required; a knowledge of electro-mechanical servo systems and synchronous transmission systems would be an advantage. Preferential consideration will be given to applicants with previous electronic experience in possession of H.N. Certificate (or equivalent), or who have served a recognised engineering apprenticeship with subsequent experience in a technical capacity; must be prepared to travel. Position will be permanent and pensionable after qualifying period. Commencing salary £450 p.a. Apply, with full details of age, qualifications and experience, to—Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Rd., Brentford, Middlesex. [8772

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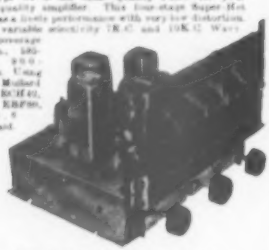

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DRAUGHTSMEN and draughtsmen for aircraft electrical installation work; applicants should be experienced in wiring layouts, design of electrical junction boxes and switch gear, etc.; previous aircraft experience not essential.—Apply in writing, stating experience, age and salary required, to Chief Draughtsman, the de Havilland Aircraft Co., Ltd., Hatfield, Herts. (18452)

AN engineer and assistants are required urgently by a large firm for work of national importance on the development of novel projects; applicants should be thoroughly familiar with medium and high voltage grid controlled rectifiers and associated electronic equipment.—Apply giving full details of qualifications and experience and quoting reference IHG to Box 0517. (18676)

DEVELOPMENT engineers required for development laboratories of light engineering factory in Stockport; must have experience in circuit design for radio, test gear and electronic instruments, HNC, City and Guild's (Telecommunications) or degree essential; staff appointment, 5-day (39½ hour) week, canteen facilities. WRITE stating age and full details of experience and qualifications, Box 1191. (18796)

INSTALLER for communication equipment required by Mullard Equipment, Ltd., Wandsworth; applicants should have had experience in the installation and testing of carrier telephone and similar equipment and should be willing to travel; permanent pensionable post, salary according to experience and qualifications.—Apply Personnel Department, Mullard Equipment, Ltd., Brathway Rd., S.W.18. (18806)

SENIOR and junior development engineers required for responsible work in radio and television development laboratories; applicants for senior position should be able to undertake development work with minimum supervision, excellent conditions and salary available for applicants who are accepted.—Apply in first case to Chief Engineer, Radio Division, McMichael Radio, Ltd., Wexham Rd., Slough, Bucks. (18816)

POST graduate and final year university students in engineering, metallurgy and chemistry are invited to send details of their records to the Staff Manager (ref. OBLC/B 285), Research Laboratories of The General Electric Co., Ltd., Wembley, Middlesex; a number of openings in interesting experimental research will be available during the coming months for men with outstanding ability and qualifications.

CATHODE ray tube engineer required to assist in work on design and developments of Teletubes. Physics degree desirable, with knowledge of chemistry an asset, but applicants with experience of this work preferred. Excellent facilities for man wishing to specialise in this field. Salary in accordance with qualifications.—Apply in writing to the Personnel Officer, Brimar Valve Works, Foots Cray, Sidcup, Kent.

ENGINEERS for the maintenance of digital computers are required by the computer section of Ferranti Ltd.; applications are invited from engineers experienced in the servicing of large electronic equipments such as radar systems and predictors; courses of instruction will be given to successful applicants, who will normally be based in Great Britain although there will be opportunities for tours of duty abroad.
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APPLICATION forms from Mr. R. J. Hebbert, Staff Manager, Ferranti Ltd., Hollinwood, Lancs. Please quote reference C.M.E. (18766)

LABORATORY technician, male (min. age 25 years), required for the Electron Microscope Laboratory, Biophysics Department, National Institute for Medical Research, The Ridgeway, Mill Hill, N.W.7; experience in electronics desirable; salary according to age and experience, permanent superannuated post after probationary period; 5-4 weeks holiday per year.—Apply in writing to Administrative Officer at above address. (18751)

AN assistant engineer is required by an engineering laboratory in Godalming for theoretical and experimental work on magnetic amplifiers and electrical instruments; applicants should possess a degree in Physics or Electrical Engineering or Higher National Certificate in Electrical Engineering; previous experience in this type of work would be an advantage; write giving full details of qualifications and experience to Box 1058. (18778)

FERRANTI Ltd. require for their radio and television department a radio engineer to design production test gear and to be responsible for maintenance and modification of existing equipments; a man of H.N.C. or equivalent qualifications with some experience of modern radio practice is needed; permanent staff appointment with pension benefits and good prospects of advancement; salary in the region of £9–£11 per week.
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JUNIOR electronic engineer, well versed in fundamental theory, required by the English Electric Company, Ltd., Luton, to work in a new department on specialised equipment employing new techniques; previous experience unnecessary, but initiative, ability to improvise and adaptability most important; salary according to qualifications.—Please write, giving full details and quoting reference "English Electric 515," to Westminster Employment Exchange, Chadwick St., London, S.W.1. (18612)

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THE GENERAL POST OFFICE has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the postmaster General's First-Class Certificate of Proficiency in Radiotelegraphy; selected candidates will be considered later for permanent pensionable posts.—Application should be made to any local office of the Ministry of Labour and National Service, quoting Order No. City 4728. [8548

DEVELOPMENT engineers, International Aeradio, Ltd., specialists in equipment design for aviation service, due to expansion of development section at Bovingdon Airport near Watford, require junior and senior radio and telegraph engineers. Salary according to experience; single quarters provided, pension scheme, 5-day week, canteen facilities.—Please apply through Local Labour Exchange to Personnel Officer, 40, Park St., London, W.1. [8696

THE ENGLISH ELECTRIC VALVE COMPANY, Chelmsford, Essex, has several attractive vacancies for graduates to undertake research and development work on vacuum tubes; applications from graduates who have recently qualified as well as those with industrial or research experience will be considered. Please write, giving full details, quoting reference 419, to Central Personnel Services, English Electric Company, Ltd., 24-30, Gillingham St., S.W.1.

TELEPHONE Transmission Engineer required by Mullard Equipment Ltd., Wandsworth; applicants should have experience in the development or testing of carrier telephone and allied equipment and should possess a good engineering degree or equivalent; some knowledge of filter or transformer design would have an advantage; permanent pensionable post, salary according to experience and qualifications.—Apply Personnel Department, Mullard Equipment, Ltd., Brathway Rd., S.W.18. [8695

DESIGN and development engineers required for a newly formed laboratory in a large engineering company of national repute, situated in the London area; applicants should have a specialised knowledge of transformers, switches or variable condensers as applicable to the radio and television field; good staff conditions operate and the post offers excellent prospects of advancement; good salary to suitable applicants.—Please write giving details of experience, quoting reference No. 1.69, to Box 0761. [8721

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E., or equivalent qualifications together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week, contributory pension scheme.—Application must be detailed and concise, and will be treated as confidential. [8250

AN experienced draughtsman is required in the expanding valve development section of the Nelson Research Laboratories, English Electric Co., Ltd., Stafford; applicants should have Higher National Certificate or better, and experience in mercury pool and high vacuum tubes is desirable but not essential.—Please write giving full details of age, qualifications and experience, quoting reference "English Electric 145A," to Westminster Employment Exchange, Chadwick St., London, S.W.1. [8758

DRAUGHTSMEN required for mechanical and intermediate required in East London area by large company engaged in light electrical and mechanical engineering; it is essential that applicants should have experience of electronic components; salaries will not be less than established rates and will be adjusted according to ability and experience; interesting class of work and excellent working conditions; pension scheme in operation.—Please write giving details of experience, quoting reference 1.96, to Box 0979.

ELECTRONIC engineer, with Higher National Certificate and experience of circuit design, required to work with mathematicians (Honours Graduates) on a new electronic computing project; outstanding opportunity, with good salary, for self-education.—Apply, quoting reference S.P.1., to Employment Manager, Vickers-Armstrongs, Ltd. (Aircraft Section), Weybridge, Surrey. Applications, with certain exceptions, are subject to the approval of the Ministry of Labour and National Service.

ROLLS-ROYCE, Ltd., Derby, have vacancies for electronic engineers experienced in maintenance and design of electronic equipment, to work upon the measurement of vibrations of engines, etc. (gas turbine and piston types), some mechanical knowledge of strength of materials, etc., an advantage; Higher School Certificate (or equivalent) or Higher National Certificate minimum requirements; salary £400 to £650 p.a. (or higher for very well qualified men, according to experience).—Apply to the Employment Manager. [8660

ELECTRONIC fitter/wiremen (3) required for high-grade rack and panel equipment, men with audio, transmitter or test gear wiring experience able to fabricate small parts, work to circuit drawings and undertake prototypes can be nominated for registered vacancies after interview; five-day week, overtime option and pension scheme; interview at company's London works, W.12, or can be arranged at company's nearest provisional depot; write, stating age and details of industrial and services experience, also technical training.—Box 1122. [8788

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TECHNICAL assistants are required by the Research Laboratories of the General Electric Co., Ltd., Stanmore Common, Stanmore, Middx., for interesting research and development work in connection with guided missiles. Applicants should have previous experience in electronics and should have received a technical education up to about National Certificate standard although possession of this qualification is not essential.—Apply in writing to the Staff Manager (Ref. GBLC/RJS/945), giving full details of age, education and experience. [8764

ELECTRONIC testers are required by the Nelson Research Laboratories, English Electric Co., Ltd., Stafford, in their expanding Electronics Laboratories. Applicants should have completed or be completing National Service and preference will be given to young men studying for higher qualifications. There are excellent opportunities for promotion to laboratory work for the right type of man.—Please write, giving full details and quoting reference "English Electric 944," to Westminster Employment Exchange, Chadwick St., London, S.W.1. [8759

VALVE development engineers are required by the Nelson Research Laboratories, English Electric Co., Ltd., Stafford, in an expanding section of the laboratories; applicants should have Inter B.Sc. or higher qualifications with development or production experience in the manufacture of mercury vapour or high vacuum tubes; a knowledge of glassworking machines and drawing office routine would be useful though not essential.—Please write giving full details and quoting reference "English Electric 508" to Westminster Employment Exchange, Chadwick St., London, S.W.1. [8757

ENGLISH ELECTRIC COMPANY, Ltd., Luton, invite applications for permanent posts in a department developing and engineering in a wide variety of specialised electronic circuits; previous experience in such work would be an asset and, for one vacancy, experience in optics or oscillography would be a recommendation; salaries will be in accordance with qualifications and experience, up to £625 per annum; the laboratories are new and pleasantly situated.—Please write, giving full details and quoting reference 1002, to Central Personnel Services, English Electric Co., Ltd., 24-50, Gillingham St., London, S.W.1. [8624

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, have vacancies for development engineers, senior development engineers, mechanical and electronic for their development laboratories on work of national importance; fields include microwave and pulse applications; salary range £400–£1,250 per annum; vacancies also exist for special engineers in component design, valve applications, electro-mechanical devices and small mechanisms; the company's laboratories provide excellent working conditions with social and welfare facilities, superannuation scheme, assistance with housing in special cases.—Apply by letter, stating age and experience, to the Personnel Manager (Ref. CHC).

ELECTRONIC engineers required by Ministry of Supply in London. *Qualifications*: British, of British parentage; recognised engineering apprenticeship; corporate membership of one of the Institutions of Civil, Mechanical or Electrical Engineers or exempting qualification. Candidates should be familiar with large scale production in industry, and have good knowledge of radar principles and practices or light-weight and miniaturised electronic airborne equipment or modern ground radio-communications equipment. Practical experience of the types of equipment used by the R.A.F. an advantage. *Duties*: Planning production, progressing and assisting in clearing manufacturing and supply problems connected with a wide range of general radar equipment, or airborne radar equipment, or ground radio communications equipment. Liaison with industry, attendance at technical meetings and examination of expansion schemes. *Salary*: Two grades within the range £655 (at age 26)–£1,280 p.a. according to age, qualifications and experience. Opportunities occur periodically for established pensionable posts. Ref. No. D261/52A. Also electronic engineer Technical Grade I. *Qualifications*: Recognised engineering apprenticeship; knowledge of radio systems (including transmitters, receivers, arrays, etc.); experience in radio manufacture; capability to assess the potentialities of manufacturers' plant and to deal with production problems. Higher National Certificate or equivalent qualification desirable. *Duties*: Connected with production of radar and associated equipment, and co-ordination of industrial manufacture and Service requirements. *Salary*: Within the range £755–£891 p.a. Opportunities for established pensionable posts may arise. Ref. No. D262/52A.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1. Quoting appropriate Ref. No. Closing date, August 14, 1952. [8761

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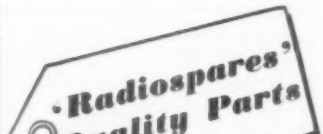

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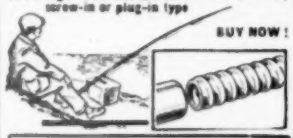

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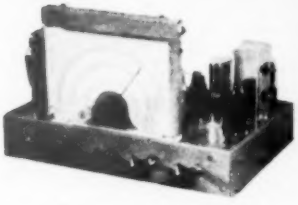

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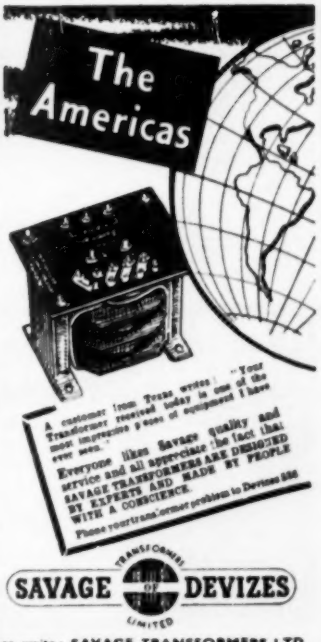

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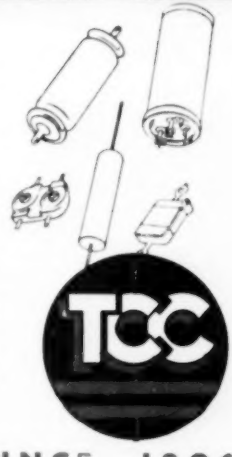

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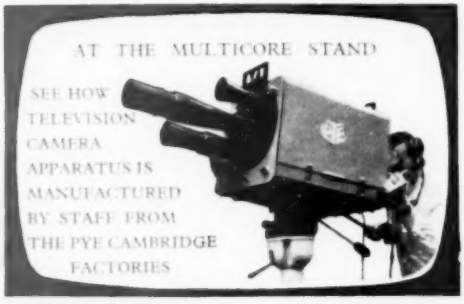

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